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# INJURY EXPERIENCE IN THE NONMETALLIC MINERAL INDUSTRIES (EXCEPT STONE AND COAL), 1964-65

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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By Forrest T. Moyer and Mary B. McNair

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# INJURY EXPERIENCE IN THE NONMETALLIC MINERAL INDUSTRIES (EXCEPT STONE AND COAL), 1964-65

by

Forrest T. Moyer[1] and Mary B. McNair[2]

## ABSTRACT

The safety record of the nonmetal mining industry during 1965 was worse than that of 1964 in all general measures of injury experience except for a slight improvement in the number and frequency rate of nonfatal injuries. Work fatalities in 1965 totaled 31 and occurred at a frequency rate of 0.29 and a severity rate of 1,711 per million man-hours of worktime. The fatality total was seven higher than in 1964 and the injury rates increased 32 and 28 percent, respectively. The total of 2,472 nonfatal injuries in 1965 was 14 less than in 1964 and the frequency rate per million man-hours worked declined 2 percent to 22.73 from 23.14 in 1964. However, the 1965 nonfatal severity rate of 1,339 per million man-hours worked was 15 percent over the 1964 rate of 1,160. This increase was largely attributable to two more permanent total and nine more permanent partial injuries in 1965 than in the preceding year. The average severity of all injuries in 1965 was 132 days lost or charged per injury or 25 days more than in 1964. Injury experience in the nonmetal mining industry, including and excluding officeworkers, for the 5-year period 1961-65 is shown in table 1.

The average number of men working on active days in 1965 was 48,429, or 625 fewer than in 1964. However, mines and mills were active an average of 5 days more for a total of 277 in 1965, and each worker averaged 2,245 hours compared to 2,190 hours in 1964. As a result, aggregate worktime of 108.7 million man-hours increased 1 percent over the 1964 total of 107.4 million hours.

## INTRODUCTION

This publication contains statistical data compiled and analyzed by the Bureau of Mines on the various aspects of injury experience at nonmetallic-mineral mines and mills. The statistical data on employment, worktime, and operating activity of the same industrial areas, obtained as correlative information to the injury data, also are presented.

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The Bureau of Mines gratefully acknowledges the cooperation of all operators of nonmetal mines and mills in submitting voluntary reports on injuries and related employment for 1964 and 1965. This cooperation makes possible the compilation of industrywide information on injury experience to aid in the promotion of safe working habits and conditions.

## GENERAL INJURY EXPERIENCE

### Mines

All general measures of injury experience worsened at nonmetal mines in 1965 when compared with similar data for 1964. The total of 1,010 disabling injuries for 1965 consisted of 21 fatal, four permanent total, 29 permanent partial, and 956 temporary total injuries (table A-1). The 1964 injury total of 924 (86 fewer than in 1965) included 18 fatal, one permanent total, 22 permanent partial, and 883 temporary total injuries (table B-1). The overall frequency rate of 26.75 disabling injuries per million man-hours worked in 1965 comprised rates of 0.56 for fatal and 26.19 for nonfatal injuries. The corresponding rates of occurrence in 1964 were 25.68 for all injuries, 0.50 for fatalities, and 25.18 for nonfatal injuries. Likewise, the 1965 severity rate of 5,048 for all injuries, worsened appreciably when compared with that of 4,389 for 1964.

A total of 11 fatal and 490 nonfatal injuries occurred in underground workings of nonmetal mines during 1965. These fatalities resulted in a frequency rate of 1.04 and a severity rate of 6,268 per million man-hours worked. The 1965 fatality total was four higher than in 1964 and the frequency and severity rates were 46 and 48 percent higher, respectively, than the 1964 rates of 0.71 and 4,245. Nonfatal injuries in 1965 had a frequency rate of 46.54 and a severity rate of 3,148 per million man-hours worked. The total of nonfatal injuries was 40 above the 1964 count of 450 and the resulting frequency and severity rates increased 2 and 57 percent, respectively, over the corresponding rates of 45.49 and 2,000 for 1964. The sharp increase in the nonfatal severity rate was largely attributable to two permanent total injuries in 1965 as compared to none in 1964 and an increase of three permanent partial injuries in 1965.

Injury experience at associated surface works of underground mines in 1965 was one fatal and 51 nonfatal injuries at respective frequency rates of 0.31 and 15.58 per million man-hours worked. The fatality total was the same as in 1964, however, the frequency rate increased 19 percent due to a reduction in the number of man-hours worked in 1965. Nonfatal injuries declined 19 in number and 15 percent in frequency rate when compared with the 70 nonfatal injuries at the rate of 18.39 per million man-hours in 1964. The 1965 fatality severity rate of 1,833 days lost per million man-hours worked was 16 percent higher than the 1964 rate of 1,576, but the 1965 severity rate of 420 for nonfatal injuries was 71 percent lower than the 1964 rate of 1,439.

At open pit mines, the 1965 safety record was improved in fatality experience but was worse in nonfatal injury experience. There were seven deaths in 1965 at respective frequency and severity rates of 0.38 and 2,271 per million man-hours worked. In 1964, 10 deaths were recorded at respective frequency and severity rates of 0.60 and 3,626 per million man-hours. Nonfatal injuries increased to 381 in 1965 compared with 305 in 1964, and the corresponding frequency rate increased to 20.60 per million man-hours from 18.43 per million man-hours in 1964. Likewise, the severity rate increased to 1,485 per million man-hours in 1965 from 1,145 per million man-hours in 1964.

During 1965 two fatal and 67 nonfatal injuries were reported for "other" surface mining operations (Frasch sulfur, salt well, brine, solar evaporation, hydraulicking, etc.). The fatalities occurred at a frequency rate of 0.37 and a severity rate of 2,198 per million man-hours worked. There were no fatalities at "other" surface mining operations in 1964. Nonfatal injuries totaled 67 in 1965 or 14 fewer than the 1964 total of 81 and the frequency rate (12.27) and severity rate (479) were 13 and 52 percent lower, respectively, than those of 14.13 and 992 recorded for 1964.

An annual average of 17,214 men worked an average of 268 days in nonmetal mines during 1965 and accumulated 37.8 million man-hours of worktime. For 1964 these worktime measures were recorded as follows: 17,087 men, 259 days, and 36.0 million man-hours, respectively.

## Mills

Fatality experience at nonmetal mills worsened appreciably in 1965 in comparison with 1964 data. The 10 deaths in 1965 occurred at a frequency rate of 0.14 and a severity rate of 845 per million man-hours worked. In 1964 six fatalities occurred at respective frequency and severity rates of 0.08 and 504 per million man-hours. Nonfatal injuries totaled 1,483 in 1965 and had a frequency rate of 20.89 per million man-hours and a severity rate of 1,141 per million man-hours. In 1964 nonfatal injuries totaled 1,580 and had respective frequency and severity rates of 22.11 and 1,046 per million man-hours.

The annual average of 31,215 men at work in mills during 1965 was 2 percent below the 1964 average of 31,967. However, mills were active 283 days or 4 days more than in 1964, and as a result total worktime in 1965 declined only slightly to 71.0 million man-hours from 71.5 million in 1964.

## Officeworkers

A total of six nonfatal injuries occurred to officeworkers in 1965 at a frequency rate of 0.65 and a severity rate of 19 per million man-hours worked. Comparable data for 1964 were four nonfatal injuries at respective frequency and severity rates of 0.45 and 27 per million man-hours.

An annual average of 4,359 officeworkers was employed in 1965, four fewer than the comparable figure for 1964. However, the officeworkers in 1965 had 264 days of work, 12 more than in 1964, and as a result, man-hours increased to 9.2 million from 8.8 million in 1964. Injury and employment data on officeworkers are shown separately only in tables A-22 and A-23 for 1965 and B-22 and B-23 for 1964 and are included with data on other workers only in part of table 1.

## GENERAL INJURY FACTORS

The injury and employment information reported for 1965 and 1964 has been analyzed and classified by common factors or elements related to the accidents which resulted in work injuries (tables A-2 through A-6 for 1965 and tables B-2 through B-6 for 1964). The analyses and classifications provide summarized industrywide injury experience. The distribution of injuries by and within these categories shows where and how the injury-causing accidents occurred. The relative prevalence of injuries to the different parts of body, the nature of injury, and the relative severity of injuries are among the summarized factors. In table A-7 for 1965 and B-7 for 1964, the safety records of mines are arranged in size groups according to the number of men working.

### Causes

Haulage accidents were the outstanding cause of fatalities at nonmetal mines and mills in both 1965 and 1964 (tables A-2 and B-2). Haulage accidents caused eight or 26 percent of all fatalities in 1965 and eight or 33 percent of all fatalities in 1964. Four or half of the eight fatal haulage accidents in 1965 occurred in mills while five of the eight deaths from this cause in 1964 were at open pit mines. Machinery accidents, the second leading cause of fatalities in 1965, resulted in six deaths, four of which occurred at open pit mines. In 1964 two of the three deaths attributed to machinery accidents occurred at open pit mines. Falls of roof, back, face, or side together were the third-ranking cause of fatal injuries in 1965 and claimed five lives, all in underground workings. In 1964, there was one fatality from a fall of roof in underground workings and two deaths were caused by falls of face or side in open pit mines.

The foregoing three accident causes accounted for 19 (61 percent) of the 1965 fatality total and 14 (58 percent) of the 1964 fatality total. Of the 12 remaining fatalities in 1965, four were from slips or falls of persons, three were from sliding or falling material or objects, two each were from electricity and handling material, and one was listed under the miscellaneous cause category. The 10 remaining fatalities in 1964 were distributed by cause as follows: Electricity, four; slips or falls of persons, two; and sliding or falling material or objects, handling material, suffocation, and explosions of gas or dust, one each.

The four ranking causes of nonfatal injuries resulted in 1,879 injuries or 76 percent of the 1965 total and 1,898 or 76 percent of the 1964 total. The causes with respective number of injuries for each year were

handling materials, 916 (1965) and 842 (1964); slips or falls of persons, 361 (1965) and 397 (1964); machinery, 318 (1965) and 303 (1964); and haulage, 284 (1965) and 356 (1964). The remaining nonfatal injuries resulted from a variety of accident causes which are listed by detailed cause in table A-2 for 1965 and in table B-2 for 1964. Injury data by mineral industry, general work location, degree of injury, and main cause of accident are shown in table A-11 for 1965 and in table B-11 for 1964.

## Part of Body Injured and Cause

Of the 31 fatalities in 1965, 17 (55 percent) involved the body in general or multiple parts; nine (29 percent) involved the head; and five (16 percent) involved the trunk. Haulage accidents caused the greater number of fatal injuries to the body in general while slips or falls of persons caused the largest number of fatal head injuries; falls of roof or back caused the largest number of fatal trunk injuries. Likewise, in 1964 the same parts of body were involved in fatal injuries but in the following decreasing order: Multiple parts, trunk, and head. Haulage accidents caused five of the 18 fatal injuries to the body in general and both of the fatal injuries to the head. One each of the four fatal injuries to the trunk was from sliding or falling material or objects, handling material, haulage, and suffocation. The relationship of the cause of accident to the part of body affected in fatal injuries is shown by work location in table A-3 for 1965 and table B-3 for 1964.

The parts of body most frequently disabled in nonfatal injuries during 1965 and 1964 were the trunk, hand and fingers, and foot and toes. In both years, injuries to the trunk occurred most frequently from handling material, slips or falls of persons, and haulage accidents. Hand and finger injuries occurred most frequently from handling material, machinery, and haulage accidents. Foot and toe injuries were most likely to result from handling material, slips or falls of persons, and haulage. More detailed distributions of the nonfatal injury data by work location and detailed cause of accident are given in table A-4 for 1965 and B-4 for 1964. Data on average severity listed in these tables show injuries to the lower extremities in 1965 and injuries to the upper extremities in 1964 to be the most severe. The distribution of injuries by degree, average severity, and injury rates by work location is shown in table A-5 for 1965 and B-5 for 1964.

## Nature of Injury

An analysis of injury data by nature of injury showed the largest number of injuries in 1965 (786) and in 1964 (747) to be the strain, sprain, or dislocation type. This nature of injury category was followed by bruise or contusion (including crushes) with 621 in 1965 and 553 in 1964 and fractures with 305 in 1965 and 315 in 1964. These three categories accounted for 74 percent of the disabilities in 1965 and 73 percent of the disabilities in 1964 for which the nature of injury was stated. More detailed descriptions

of nature of injury data by work location, degree of injury, average severity, and injury rates are shown in table A-6 for 1965 and B-6 for 1964.

## Size of Mines and Mills

Injury experience and employment data on mines and mills grouped by numbers of employees are shown in table A-7 for 1965 and B-7 for 1964. Underground mines (including associated surface work) employing 250 men or more had the lowest combined (fatal and nonfatal) injury-frequency rates in both 1965 and 1964. The 1965 rate of 21.41 injuries per million man-hours worked was 23 percent lower than that of 27.65 in 1964. Overall injury frequency for underground mines employing one to four men was the least favorable in 1965 (72.09) while mines in the 10 to 19 group had the least favorable rate in 1964 (59.83). At open pit mines, operations in the 100 to 249 group achieved the lowest injury-frequency rate during 1965 (11.48) and 1964 (12.52). Open pit mines employing 10 to 19 men had the most unfavorable rate in 1965 (27.78) while those in the five to nine group had the worst rate in 1964 (33.09). At "other" surface mining operations, the lowest injury-frequency rate in 1965 (3.64) was achieved by mines employing 100 to 249 men. The lowest rate in 1964 (6.11) was recorded for mines in the 50- to 99-man group. Mines in the 5 to 9 group had the least favorable rates in both 1965 (25.21) and 1964 (38.54). Mills employing 250 men or more had the lowest injury-frequency rate of all the size groups of mills in both 1965 and 1964.

# INJURY EXPERIENCE BY MINERAL INDUSTRY

## Clay Mines and Mills

The four fatalities in clay mines during 1965 were three fewer than the number recorded for 1964. Three of the fatalities in 1965 occurred underground and one was at an open pit mine (table A-12). In 1964, there was one fatality underground and six at open pit mines (B-12). The resulting fatality-frequency rate for 1965 was 0.40 per million man-hours worked. This rate was 47 percent lower than the 1964 rate of 0.75. Likewise, the 1965 fatal severity rate of 2,430 per million man-hours was a 46-percent decrease from the 1964 rate of 4,484. A total of 291 nonfatal disabling work injuries occurred during 1965, 37 more than in 1964. The 1965 nonfatal frequency rate, 29.46, was a 9-percent increase over the 1964 rate of 27.12 while the 1965 severity rate, 1,604, declined 5 percent from the 1964 rate of 1,685.

The five fatalities in clay mills in 1965 and the four in 1964 occurred at respective frequency rates of 0.17 and 0.12 per million man-hours worked. A total of 890 nonfatal injuries at mills in 1965 had a frequency rate of 29.55 per million man-hours. Comparable data for 1964 were 1,011 nonfatal injuries at a rate of 31.54 per million man-hours. The severity rates for fatal and nonfatal injuries at clay mills during 1965 were 996 and 1,051, respectively, per million man-hours. The corresponding rates for 1964 were 749 and 1,276, respectively.

The annual average of 5,544 men employed in clay mines during 1965 increased slightly over 1964. Aggregate worktime in 1965 increased to 9.9 million man-hours from 9.4 million in 1964. At nonmetal mills, the average number of men working in 1965 was 14,136 or 1,114 fewer than in 1964. Total man-hours of worktime dropped to 30.1 million in 1965 from 32.1 million in 1964. Of the total workforce in clay mines and mills, 42 percent of the 1965 total and 45 percent of the 1964 total worked in operations in the following five States: Georgia, North Carolina, Ohio, Pennsylvania, and Texas. Operations in Georgia had the largest number of combined fatal and nonfatal injuries in both 1965 and 1964. More detailed descriptions of injury experience and employment data by State and general work location at clay mines and mills are shown in table A-14 for 1965 and in table B-14 for 1964.

## Gypsum Mines and Mills

All general measures of injury experience worsened at gypsum mines during 1965. There were two fatalities that resulted in a frequency rate of 1.00 and a severity rate of 5,996 per million man-hours worked. One of the deaths occurred underground and the other at an open pit mine. There were no fatalities at gypsum mines in 1964. A total of 19 nonfatal injuries occurred at gypsum mines in 1965, four more than in 1964. The resulting nonfatal frequency rate was 9.49 or 32 percent higher than the 1964 rate of 7.17, and the severity rate advanced to 442, 46 percent above the 1964 rate of 302. Seven of the nonfatal injuries in 1965 occurred in underground workings and 12 occurred at open pit mines. The nonfatal injury count in underground workings was four more than in 1964 while the number of nonfatal injuries at open pit mines equaled the 1964 total.

There were no fatalities at gypsum mills in either 1965 or 1964. Although the total of 25 nonfatal injuries in 1965 was five more than in 1964, the frequency rate of 3.81 was 34 percent lower owing primarily to the larger proportional gain of 89 percent in man-hours worked. Similarly, the injury-severity rate of 588 days lost per million man-hours was 67 percent below the corresponding rate of 1,804 for 1964.

An annual average of 970 men worked 2.0 million man-hours at gypsum mines in 1965, slight declines from the 1964 figures of 1,019 men and 2.1 million man-hours. At gypsum mills, however, worktime data increased appreciably over 1964, owing to the inclusion of additional mills in 1965. The average of 2,890 men in 1965 worked 6.6 million man-hours. In 1965 operators in Iowa had the largest number (548) of gypsum mine and mill workers; in 1964 the greater number (469) was employed at operations in New York. Operations in California had the most injuries in both 1965 and 1964. More detailed descriptions of injury experience and employment data by State and general work location at gypsum mines and mills are shown in table A-15 for 1965 and in table B-15 for 1964.

## Phosphate Rock Mines and Mills

There were two fatalities at phosphate rock mines in both 1965 and 1964. The fatalities in 1965 resulted in a frequency rate of 0.34 and a severity rate of 2,013 per million man-hours worked. Owing to an increase in the number of man-hours worked during 1965, these rates were lower than the corresponding rates of 0.40 and 2,370 recorded for 1964. In each year, one fatality occurred in underground workings and one was at an open pit mine. The nonfatal injury total in 1965 increased to 122 from 92 in 1964. Likewise, the frequency rate per million man-hours worked increased to 20.46 in 1965 from 18.17 in 1964. Although the number and frequency of nonfatal injuries were higher during 1965, the severity rate per million man-hours worked declined 57 percent to 447 in 1965 from 1,040 in 1964.

Injury experience at phosphate rock mills worsened in 1965. Four fatalities were recorded for 1965 at a frequency rate of 0.65 and a severity rate of 3,872 per million man-hours worked. There were no fatalities at phosphate rock mills in 1964. The nonfatal injury total in 1965 increased to 54 from 38 in 1964. Similarly, the frequency rate per million man-hours worked increased to 8.71 in 1965 from 6.89 in 1964 and the severity rate per million man-hours increased to 1,321 in 1965 from 1,017 in 1964.

An average number of 2,507 men worked 6.0 million man-hours at phosphate rock mines in 1965. In comparison with 1964, there were 383 more men at work and worktime increased 18 percent over the 5.1 million man-hours accumulated in 1964. At phosphate rock mills, an average of 2,476 men worked 6.2 million hours in 1965 compared with 2,163 men and 5.5 million man-hours in 1964. Operations in Florida employed more than 50 percent of the phosphate rock and mill workers in both 1965 and 1964. These Florida operations had four of the six fatalities in 1965 and one of the two deaths in 1964. Although the largest number of nonfatal injuries occurred in Florida operations during each year, the nonfatal frequency rate was lower than in any other State. More detailed descriptions of injury experience and employment data by State and general work location at phosphate rock mines and mills are shown in table A-16 for 1965 and in table B-16 for 1964.

## Potash Mines and Mills

Fatality experience was greatly improved at potash mines in 1965 when compared with 1964. One fatality in 1965 resulted in a frequency rate of 0.20 and a severity rate of 1,199 per million man-hours. In 1964, four fatalities occurred at respective frequency and severity rates of 0.74 and 4,458 per million man-hours. The death in 1965 as well as the four fatalities in 1964 were in underground workings of potash mines. For nonfatal injuries, the 1965 safety record was unfavorable with 192 injuries recorded or 21 more than in 1964. The frequency rate for nonfatal injuries in 1965 increased to 38.37 from 31.76 in 1964 and the severity rate jumped 87 percent to 3,135 per million man-hours in 1965 from 1,680 per million man-hours in 1964.

There were no fatalities at potash mills in 1965 compared with one in 1964 which resulted in a frequency rate of 0.38 and a severity rate of 2,251. The number of nonfatal injuries at potash mills in 1965 was 72 or 27 more than in 1964. The frequency rate of 22.40 for 1965 was 33 percent higher than the 1964 rate of 16.88 while the severity rate of 1,959 was nearly five times higher than the 1964 rate of 394.

The annual average of 1,753 men working at potash mines in 1965 was 269 fewer men working than in 1964 and aggregate worktime declined to 5.0 million man-hours from 5.4 million in 1964. At potash mills, there were 1,126 men working in 1965 compared with 1,003 men in 1964. Worktime increased to 3.2 million man-hours in 1965 from 2.7 million in 1964. The 2,879 potash mine and mill workers in 1965 worked at 12 mines and 11 mills in the States of California, New Mexico, and Utah. In 1964, the total workforce of 3,025 men was employed in 13 mines and nine mills of New Mexico and Utah. More detailed descriptions of injury experience and employment data by State and general work location at potash mines and mills are shown in table A-17 for 1965 and in table B-17 for 1964.

## Salt Mines and Mills

The 1965 safety record of salt mines worsened in fatality experience but improved in nonfatal injury experience. The three fatalities during 1965 occurred at a frequency rate of 0.80 and a severity rate of 4,807 per million man-hours worked. In 1964, the one fatality resulted in respective frequency and severity rates of 0.29 and 1,720. One of the deaths in 1965 and the only fatality recorded for 1964 occurred at surface operations connected with underground mines. The other two fatalities in 1965 occurred in underground workings. For nonfatal injuries, both the number and occurrence rates were reduced in 1965. The total of 97 nonfatal disabling work injuries was 25 fewer than in 1964 and the frequency rate of 25.90 per million man-hours dropped 26 percent from the 1964 rate of 34.98. The 1965 severity rate of 2,297 per million man-hours was 12 percent lower than the 1964 rate of 2,614.

There were no fatalities at salt mills in either 1965 or 1964. The total of 154 nonfatal injuries for 1965 was 29 fewer than in 1964. However, owing to a larger proportional decline in the number of man-hours worked, the frequency rate increased 5 percent to 17.17 in 1965 from 16.30 in 1964. The severity rate increased 32 percent to 867 in 1965 from 657 in 1964.

The average of 1,638 men at work and worktime of 3.7 million man-hours in salt mines during 1965 were each higher than the corresponding figures of 1,551 men and 3.5 million man-hours for 1964. At salt mills, the average of 3,909 men working in 1965 was 961 fewer men than in 1964 and worktime declined to 9.0 million man-hours in 1965 from 11.2 million in 1964. Seventy percent of the 1965 workforce and 72 percent of the 1964 workforce was employed in operations of the following five States: Kansas, Louisiana, Michigan, New York, and Ohio. The largest number of injuries in each year occurred in the State of New York. More detailed descriptions of injury

experience and employment data by State and general work location at salt mines and mills are shown in table A-18 for 1965 and in table B-18 for 1964.

## Sulfur Mines and Mills

There were two fatalities at sulfur mines in 1965 compared with none in 1964. The resulting frequency and severity rates were 0.45 and 2,687, respectively, per million man-hours of exposure. Both of the fatalities in 1965 occurred at Frasch operations classified as "other" surface mining operations. A total of 55 nonfatal disabling work injuries occurred in 1965 at a frequency rate of 12.32 and a severity rate of 387 per million man-hours worked. The 53 nonfatal injuries in 1964 had respective frequency and severity rates of 12.91 and 418 per million man-hours.

No fatalities were reported during 1965 or 1964 at sulfur mills. Two nonfatal injuries occurred in 1965 at a frequency rate of 81.97 and a severity rate of 82 per million man-hours worked. There were no nonfatal injuries in 1964.

The annual average of 1,371 men employed at sulfur mines during 1965 was 58 more men working than in 1964. Aggregate worktime in 1965 increased to 4.5 million man-hours from 4.1 million in 1964. At sulfur mills, the average number of men working in 1965 was 10 or one less than in 1964. In both 1965 and 1964, 61 percent of the total sulfur mine and mill workers were employed at operations in Texas. The two fatalities in 1965 occurred at operations in Louisiana. More detailed descriptions of injury experience and employment data by State and general work location at sulfur mines and mills are shown in table A-19 for 1965 and in table B-19 for 1964.

## Miscellaneous Nonmetal Mines and Mills

All general measures of injury experience worsened at "miscellaneous" nonmetal mines (barite, boron minerals, feldspar, fluorite, mica, talc, etc.) in 1965 when compared with 1964. Seven fatalities occurred in 1965 at a frequency rate of 1.04 and a severity rate of 6,263 per million man-hours of exposure. The fatality total was three higher than in 1964 and the injury rates increased 68 and 69 percent, respectively, over those of 0.62 and 3,705 recorded for 1964. Three of the fatalities in 1965 occurred underground and four were at open pit mines. In 1964 one fatality occurred underground and three were at open pit mines. The nonfatal injury total for 1965 increased to 213 from 199 in 1964, and the frequency and severity rates increased, respectively, to 31.76 and 2,864 in 1965 from 30.72 and 1,289 in 1964.

There was one fatality at "miscellaneous" nonmetal mills in both 1965 and 1964. The frequency rate, 0.06 per million man-hours worked, was the same for both years while the severity rate increased to 377 in 1965 from 363 in 1964. A total of 286 nonfatal disabling work injuries, three more than

in 1964, occurred in 1965 at a frequency rate of 17.99 and a severity rate of 1,463. The 1965 frequency rate increased 5 percent over the 1964 rate of 17.14 while the severity rate increased 78 percent over the 1964 rate of 822.

An average of 3,431 men in "miscellaneous" nonmetal mines during 1965 worked 6.7 million man-hours. The number of men working was 177 fewer than in 1964, however, in 242 days or 19 more days than in 1964, the men accumulated 4 percent more man-hours than the total of 6.5 million recorded for 1964. At "miscellaneous" nonmetal mills, there were 6,668 men working or 413 fewer in 1965 than in 1964, and worktime declined to 15.9 million man-hours from 16.5 million in 1964. Of the 10,099 "miscellaneous" nonmetal mine and mill workers in 1965, the largest number (3,155) was employed at operations in California. Likewise, in 1964, 3,191 of the 10,689 men working were employed at operations in California. More detailed descriptions of injury experience and employment data by State and general work location at "miscellaneous" nonmetal mines and mills are shown in table A-20 for 1965 and in table B-20 for 1964. Injury experience and employment data by mineral industry and general work location at "miscellaneous" nonmetal mines and mills are shown in table A-13 for 1965 and in table B-13 for 1964.

## INJURY EXPERIENCE BY STATE

Injury data on nonmetal mines and mills by State and degree of injury are shown in table A-8 for 1965 and B-8 for 1964. Injury data by State, general work location, and main cause of accident are shown in tables A-9 and A-10 for 1965 and B-9 and B-10 for 1964. Injury experience and accompanying employment data by State and general work location are shown in table A-21 for 1965 and B-21 for 1964.

Of the States in which fatal injuries occurred, the fatality rate at mines in 1965 ranged from 0.53 per million man-hours worked in California mines to 22.29 per million man-hours worked in Hawaii mines. For nonfatal injuries, the frequency rate ranged from 7.53 per million man-hours worked in Maryland mines to 85.60 per million man-hours worked in Oregon mines. At mills the lowest fatality frequency rate was 0.34 at mills in Georgia while the highest (4.27) was at mills in Arizona. The nonfatal frequency rate ranged from 5.33 per million man-hours worked at mills in West Virginia to 71.98 per million man-hours worked at mills in Maryland. In 1964, the fatality frequency rate at mines ranged from 0.29 in Texas mines to 23.94 in Minnesota mines. The nonfatal frequency rate ranged from 3.21 in Mississippi mines to 97.88 in Arkansas mines. At mills, the lowest fatality frequency rate was 0.12 for mills in California and the highest was 2.07 for mills in Utah. The nonfatal frequency rate ranged from 8.04 for mills in Florida to 62.03 for mills in Minnesota.

More than 50 percent of the nonmetal mine and mill workers in both 1965 and 1964 were employed in the following nine States: California, Florida, Georgia, Louisiana, New Mexico, New York, North Carolina, Ohio, and Texas. The

largest number of active mine and mill operations during each year was in California.

## SCOPE OF STATISTICS

The statistical data of this report covers the work experience of all personnel engaged in exploration, development, production, maintenance, repair, and force-account construction work, including supervisory and technical personnel and working partners. Information on officeworkers at the mine and mill appears separately, and is presented only as mentioned specifically in table titles.

Most of the information in this report was received directly from the operators. However, to obtain complete coverage of an industry including those establishments failing to report, it was necessary to estimate some of the data on the number of men employed and their worktime, using information received from other sources. Injury experience for these nonreporters was projected from the aggregate injury experience of the same industry. Fatality and permanent-injury experience were not projected. Every effort has been made to present complete and accurate injury and employment data.

The terminology used throughout this report is that used generally by the mineral-extractive industries and by the Bureau of Mines. The recording and measuring of work-injury experience follows the American Standard Method.3/ The classification and extent of industries is in close general agreement with the Standard Industrial Classification.4/

## DEFINITION OF TERMS

Key terms used in this publication are defined or described as follows:

Disabling work injury.--Any injury suffered by a person which arises out of and in the course of his employment which results in death, permanent total disability, permanent partial disability, or temporary total disability.

Fatality.--Any death resulting from a disabling work injury, regardless of the time intervening between injury and death.

Permanent total disability.--Any disabling work injury other than death which permanently and totally incapacitates an employee from following

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3/ American Standards Association, Inc. American Standard Method of Measuring Work Injury Experience, Z16.1-revised 1954 (reaffirmed 1959) pp. 7-8.

4/ Executive Office of the President, Bureau of the Budget. Standard Industrial Classification Manual, 1957 revision.

any gainful occupation, or which results in the loss of or the complete loss of use of both or any two of the following: Hands, arms, legs, feet, or eyes.

Permanent partial disability.--Any disabling work injury other than death or permanent total disability which results in the complete loss or loss of use of any member or part of a member of the body, or any permanent impairment of functions of the body or part thereof, regardless of any preexisting disability of the injured member or impaired body function.

Temporary total disability.--Any disabling work injury which does not result in death or permanent impairment, but which renders the injured person unable to perform a regularly established job which is open and available to him, during the entire time interval corresponding to the hours of his regular shift on any one or more days (including Sundays, days off, or plant shutdown) subsequent to the date of injury.

Lost time injury.--Same as disabling work injury.

Disabling injury-frequency rate.--The number of disabling work injuries per million man-hours of exposure. Calculated by multiplying the total number of injuries by 1 million and dividing the product by the total man-hours of worktime.

Disabling injury-severity rate.--The number of days lost or charged from disabling work injuries per million man-hours of exposure. Calculated by multiplying the total number of days lost or charged by 1 million and dividing the product by the total man-hours of worktime.

Average severity.--The average number of days lost or charged per disabling injury. Calculated from the total number of days lost or charged divided by the total number of disabling injuries.

Days lost.--The number of full calendar days the injured employee was unable to work as the result of a temporary total disability.

Days charged.--All fatalities and permanent total disabilities have a standard time-loss charge of 6,000 days. Injuries resulting in permanent partial disability are assigned a time-loss charge depending upon the particular injury as specified by the American Standard Table of Scheduled Charges.

Men employed.--Average number of men at work each day the mine or plant was active for production or development. As absenteeism and labor turnover are considered, this number is lower than the number available for work as measured by a count of names on the payroll.

Underground mine.--An underground mining establishment separated into an underground department and a surface department which includes the associated supply, maintenance, repair, and yard facilities on the surface.

Open pit.--An open pit mining establishment including the pit and associated surface facilities.

Other surface mining.--Placer, dredging, hydraulicking, leaching, wells and brines, Frasch sulfur, and exploration establishments as well as stockpiles, mine dumps, and old tailings dumps worked for recovery of ore.

Mill.--An establishment processing ores and minerals by washing, screening, crushing, grinding, concentrating, or other means. The mill may be in conjunction with a mining operation or be operated independently as a custom mill.

Accident-cause classification.--The cause classification used in this report has been developed by the Bureau of Mines through many years of analyzing descriptions of accidents which resulted in injuries at mineral extractive and processing operations. It is designed to meet the particular needs of accident-prevention work in the mineral industries in which the working environment of most employees changes continuously as work progresses through each day. Examinations and trials with other methods of cause classification have demonstrated the Bureau's method to be the most useful for the industries covered. The intent of the classification is to point, in as fine detail as possible, to the hazards in environment, work activity, equipment, materials, or improper work procedures which were the primary causes of accidents. These hazards are those requiring corrective attention--through the technical aspects of safety engineering, inspection, and education--in proportion to the seriousness or the number of injuries ascribed to them.

The Bureau's classification comprises 19 main or major groups of descriptive causes covering the hazards of daily work. Each major group is broken down into a varying number of detailed causes (tables A-2 and B-2) pointing to more particular hazards within the general causes. For example, falls-of-roof or -back accidents result from a constantly changing environmental hazard for which proper support has not been provided or for which the changing roof conditions have not been properly analyzed. The most useful set of detailed causes under the main fall-of-roof category has been determined to be the work activity of the injured when the roof or back fell. It is during those work activities with the larger number of injuries that more attention is required for roof support and roof-condition analysis.

Other major cause groups point to defective equipment or improper use as in the handtool category. The detailed cause under this general group points to the tool which was defective or not used properly.

The following descriptions of the major causes provide additional definitions particularly in the inclusions or exclusions of accidents for which the primary cause may be subject to misinterpretation. With these descriptions, the detailed causes under each major group are self-explanatory.

Falls of roof or back.--Falls of ore or rock from their in-place location in the mine roof, back, hanging wall, overhead, or brow. Excludes falls of rock or ore caused by equipment knocking out support or falls from pressure bumps or bursts.

Falls of face or side.--Any fall of ore, rock, or waste from their in-place location in the face, wall, breast, side, rib, foot or hanging wall, or pillar in underground workings and from the side, face, or wall in open-pits. Excludes falls from equipment knocking out support or falls from pressure bumps or bursts.

Pressure bumps or bursts.--Falling or flying roof, back, face, or side material caused by pressure bumps or bursts.

Inrush of water or material.--Includes inrushes of water or unconsolidated material caused by mining into or too close to flooded old workings, or unconsolidated sediments such as sand.

Other falling materials or objects.--Rolling, shifting, sliding or falling materials or objects not being handled or disturbed by the injured worker. Includes ore or rock already broken from its in-place position.

Slips or falls of persons.--Slips or falls on the same level and from an elevation are grouped separately. Slips or falls in or from haulage equipment that resulted from an accident on haulage, from the motion of haulage equipment or while getting on or off haulage equipment are excluded. Slips or falls into moving or operating machinery or into electricity also are excluded.

Handling materials.--Includes moving, lifting, loading, carrying, or installing ore, rock, supplies, or materials and flying particles from materials being handled or moved.

Handtools.--Accidents from tools in hands of injured worker or tools in hands of fellow worker, except power-driven tools. Includes flying pieces from tools being used.

Stepping or kneeling on sharp or loose objects.--Stepping or kneeling on sharp or loose objects, slips or falls from stepping on loose objects, and cases resulting in bursitis or "miner's knee", from working on hands and/or knees.

Striking or bumping against objects.--Cases of walking or bumping into stationary objects. Excludes cases of striking or bumping in the course of servicing equipment, repairing, handling materials, using handtool, operating machinery or haulage equipment, etc. Excludes cases of striking or bumping moving or operating machinery or electricity.

Haulage.--Haulage accidents are divided into the following six groups: (1) mine cages, cars, or motors; (2) shuttle cars, transloaders, and small mobile trucks; (3) railroad cars and locomotives; (4) water transportation; (5) automobile, gasoline or diesel trucks, tractors, etc.; and (6) miscellaneous equipment (ropes, animals, belts, etc.). Included in the haulage category are falls of roof, back, or face from equipment knocking out supports; slips or falls of persons in or from haulage that resulted from an accident to the equipment, from the motion of the equipment, or while getting on or off equipment; and flying particles set in motion by haulage equipment or draft therefrom.

Explosions of gas or dust.--Explosions of gas or dust in the mine environment.

Explosives and breaking agents.--Cases in which the detonation, fumes, flying fragments or improper use of the explosive or breaking agent, fuses, caps, or detonators, were the cause of injury.

Electricity.--Cases resulting from contact with electric current or from arcs or flashes.

Machinery.--Accidents while operating machines are separated from those while moving or tramming a whole machine, except continuous mining machines. Injuries occurring while moving a repair part of a machine are classed under "handling materials." Included in the machinery classification are falls of roof or face from machinery knocking out support, setting-up or servicing machinery, and flying particles set in motion by machinery. Excluded from the classification are accidents occurring in the course of repairing machines, unless the accident resulted from in-motion machinery.

Suffocation.--Divided into (1) suffocation from naturally occurring gases from strata or processing gases, or from oxygen-depleted atmospheres and (2) from foreign gases such as from oil or gasoline fumes, or from gases and smoke drawn underground from a surface fire, or from gas wells. Excludes gases from mine fires, explosions, and explosives use.

Mine fires and suffocation from fires.--Mine fire accidents are divided into (1) mine fires in which mineral or timber is burning, and (2) other fires in which equipment or material other than mineral or timber is burning.

Miscellaneous causes.--Includes flying particles from draft or wind; gas or burns from carbide; gas, burns, or flying materials or flashes from acetylene and electric welding and cutting; irritations and burns from battery fluid or other acids; burns from controlled wood, oil or coal fires, steam, hot grease, oil, etc.; and all other accidents not elsewhere classified.

# HISTORICAL DEVELOPMENT OF INJURY AND EMPLOYMENT EXPERIENCE REPORTING AND ANALYSES IN THE NONMETALLIC MINERAL INDUSTRY

Statistical data on injuries and related employment at nonmetal mines first became available when the Bureau of Mines received reports from operating companies in 1911. The nonmetal mine data were published under the classification of miscellaneous mineral mines for the period 1911 to 1914 inclusive. In 1915, the classification was changed to nonmetallic mineral mines. From 1911 to 1914 inclusive, the Bureau's classification of nonfatal injuries covered two groups. "Serious" injuries, disabling a workman for more than 20 days; and "slight" injuries, causing disability not exceeding 20 days but longer than the remainder of the day of injury. From 1915 to 1929, a "serious" injury, as the term was used in Bureau reports, signified a temporary injury as disabling an employee for more than 14 days. Beginning in 1930, temporary total injuries have been included in a single group, each injury causing disability for more than the remainder of the day on which the injury occurred. Nonfatal injuries are classified by severity of injuries as follows: Permanent total, permanent partial, and temporary total.

From 1911 through 1916, injury-frequency rates were indicated by showing the number of injuries per thousand men employed. Beginning in 1917 and continuing through 1930, a method was used whereby the total number of employees was calculated to an equivalent number of 300-day workers which was used to determine the injury rates per thousand 300-day workers.

Beginning in 1931, the Bureau of Mines collected and used the number of man-hours of exposure as the basis for determining injury-frequency rates. The injury-frequency rate per million man-hours worked can be used for direct comparison of injury experience between different years, different mines, and different industries. The use of the rate eliminates such effects as variations in the number of men working at different mines, the number of working days per year, and the number of working hours per day. Most of the operating companies report the number of man-hours worked, and that figure is accepted by the Bureau as the best record obtainable. In some instances, however, it has been necessary to approximate the number of days on which the employees worked, and then multiply the product by the number of hours worked per day (length of working shift).

Published data for 1942 to 1944 inclusive were revised to include fluorspar operations with nonmetal mines. The clay industry, which includes all clay and shale operations, was included with the data on nonmetal mines beginning with 1955. Clay mills at the minesite were first included in the data for 1956.

In 1956 data on injury and employment experience in the nonmetal industries were separated from the former series of reports, "Injury Experience in the Metal and Nonmetal Industries," and were published in a new series, "Injury Experience in the Nonmetal Industries." Injury and

employment experience at nonmetal mills were first compiled in 1956. Also at this time the Bureau requested the operators to furnish a brief description and the degree of each disabling work injury and to report the number of days of disability for each temporary total injury. With this data, injury-severity rates have been calculated for the nonmetal mining and milling industry in the United States beginning with 1956.

Beginning in 1962, the activity classifications "Ore-dressing" and "Auxiliary works" were dropped and the combined data on these activities were designated "Mills" and associated with the nonmetal mine data.

The annual injury experience and employment data on all nonmetal mines and mills in the United States, 1931-65, are shown in table 2.

TABLE 1. - Salient statistics on injuries, injury rates, and employment data on nonmetal mines and mills in the United States, 1961-65

| | Excluding officeworkers | | | | | Including officeworkers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1961 | 1962 | 1963 | 1964 | 1965 | 1961 | 1962 | 1963 | 1964 | 1965 |
| Injuries: | | | | | | | | | | |
| Fatal | 21 | 23 | 33 | 24 | 31 | 21 | 23 | 33 | 24 | 31 |
| Nonfatal: | | | | | | | | | | |
| Permanent total | 3 | 4 | - | 4 | 6 | 3 | 4 | - | 4 | 6 |
| Permanent partial | 80 | 65 | 58 | 60 | 69 | 80 | 65 | 58 | 60 | 69 |
| Temporary total | 2,458 | 2,258 | 2,275 | 2,422 | 2,397 | 2,467 | 2,265 | 2,279 | 2,426 | 2,403 |
| Total nonfatal | 2,541 | 2,327 | 2,333 | 2,486 | 2,472 | 2,550 | 2,334 | 2,337 | 2,490 | 2,478 |
| Grand total | 2,562 | 2,350 | 2,366 | 2,510 | 2,503 | 2,571 | 2,357 | 2,370 | 2,514 | 2,509 |
| Injury rates: | | | | | | | | | | |
| Frequency per million man-hours: | | | | | | | | | | |
| Fatal | 0.18 | 0.21 | 0.30 | 0.22 | 0.29 | 0.16 | 0.20 | 0.28 | 0.21 | 0.26 |
| Nonfatal | 21.27 | 21.73 | 21.51 | 23.14 | 22.73 | 20.01 | 20.34 | 20.15 | 21.42 | 21.02 |
| Total or average | 21.45 | 21.94 | 21.81 | 23.36 | 23.02 | 20.18 | 20.55 | 20.44 | 21.63 | 21.28 |
| Severity per million man-hours: | | | | | | | | | | |
| Fatal | 1,055 | 1,288 | 1,825 | 1,340 | 1,711 | 989 | 1,203 | 1,707 | 1,239 | 1,577 |
| Nonfatal | 994 | 1,113 | 687 | 1,160 | 1,339 | 933 | 1,041 | 643 | 1,075 | 1,237 |
| Total or average | 2,049 | 2,402 | 2,512 | 2,501 | 3,050 | 1,922 | 2,244 | 2,350 | 2,313 | 2,814 |
| Average severity (days lost per injury): | | | | | | | | | | |
| Permanent partial | 631 | 591 | 499 | 773 | 836 | 631 | 591 | 499 | 773 | 836 |
| Temporary total | 20 | 25 | 20 | 22 | 22 | 20 | 25 | 20 | 22 | 22 |
| All injuries | 96 | 109 | 115 | 107 | 132 | 95 | 109 | 115 | 107 | 132 |
| Men employed | 57,312 | 51,817 | 49,302 | 49,054 | 48,429 | 61,137 | 56,121 | 52,932 | 53,417 | 52,788 |
| Average days active | 259 | 253 | 273 | 272 | 277 | 259 | 250 | 272 | 270 | 276 |
| Man-days worked | 14,817,827 | 13,090,818 | 13,439,608 | 13,333,757 | 13,430,478 | 15,813,592 | 14,047,921 | 14,384,040 | 14,433,009 | 14,580,714 |
| Man-hours worked | 119,441,616 | 107,104,694 | 108,483,375 | 107,437,869 | 108,735,036 | 127,428,903 | 114,723,470 | 115,965,808 | 116,238,743 | 117,908,334 |
| Average hours per man per day | 8.06 | 8.18 | 8.07 | 8.06 | 8.1 | 8.06 | 8.17 | 8.06 | 8.05 | 8.1 |
| Average hours per man per year | 2,084 | 2,067 | 2,200 | 2,190 | 2,245 | 2,084 | 2,044 | 2,191 | 2,176 | 2,234 |
| Active mines | 2,611 | 2,306 | 2,095 | 2,190 | 2,167 | 2,611 | 2,306 | 2,095 | 2,190 | 2,167 |
| Active mills | 996 | 928 | 896 | 911 | 845 | 996 | 928 | 896 | 911 | 845 |

TABLE 2. - Injury experience and employment data on nonmetal mines and mills in the United States, 1931-65 1/

| Year | Injuries | | Frequency rates per million man-hours | | Men employed | Average days active | Man-days worked (thousands) | Man-hours worked (thousands) |
|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Fatal | Nonfatal | | | | |
| At Mines | | | | | | | | |
| 1931 | 11 | 841 | 0.61 | 46.88 | 8,949 | 227 | 2,029 | 17,941 |
| 1932 | 7 | 528 | .59 | 44.65 | 6,686 | 201 | 1,347 | 11,825 |
| 1933 | 8 | 745 | .57 | 52.71 | 7,678 | 225 | 1,729 | 14,134 |
| 1934 | 8 | 787 | .53 | 51.82 | 8,234 | 236 | 1,947 | 15,187 |
| 1935 | 7 | 813 | .43 | 50.28 | 8,339 | 250 | 2,086 | 16,168 |
| 1936 | 4 | 1,044 | .19 | 48.43 | 10,380 | 259 | 2,689 | 21,556 |
| 1937 | 13 | 987 | .63 | 48.06 | 10,017 | 256 | 2,561 | 20,536 |
| 1938 | 6 | 726 | .34 | 40.72 | 9,526 | 236 | 2,251 | 17,827 |
| 1939 | 10 | 719 | .58 | 41.61 | 9,630 | 228 | 2,196 | 17,281 |
| 1940 | 14 | 826 | .74 | 43.50 | 9,780 | 247 | 2,416 | 18,988 |
| 1941 | 17 | 1,182 | .73 | 50.89 | 11,088 | 263 | 2,920 | 23,225 |
| 1942 2/ | 22 | 1,537 | .78 | 54.71 | 12,677 | 274 | 3,473 | 28,093 |
| 1943 | 25 | 1,471 | .89 | 52.54 | 12,713 | 269 | 3,426 | 27,999 |
| 1944 | 17 | 1,283 | .66 | 49.81 | 11,261 | 282 | 3,173 | 25,760 |
| 1945 | 16 | 1,145 | .65 | 46.52 | 10,371 | 291 | 3,016 | 24,613 |
| 1946 | 26 | 1,369 | .97 | 50.94 | 11,312 | 291 | 3,297 | 26,877 |
| 1947 | 12 | 1,308 | .42 | 45.40 | 12,176 | 292 | 3,555 | 28,809 |
| 1948 | 15 | 1,176 | .54 | 42.33 | 11,950 | 287 | 3,432 | 27,784 |
| 1949 | 10 | 1,125 | .37 | 41.75 | 12,077 | 277 | 3,340 | 26,948 |
| 1950 | 19 | 1,238 | .67 | 43.51 | 11,977 | 293 | 3,512 | 28,456 |
| 1951 | 17 | 1,351 | .56 | 44.84 | 12,500 | 298 | 3,729 | 30,130 |
| 1952 | 14 | 1,171 | .48 | 40.44 | 12,447 | 288 | 3,588 | 28,954 |
| 1953 | 22 | 1,419 | .72 | 46.54 | 12,765 | 292 | 3,727 | 30,488 |
| 1954 | 9 | 956 | .30 | 32.34 | 12,810 | 284 | 3,638 | 29,564 |
| 1955 3/ | 19 | 1,156 | .61 | 37.18 | 14,504 | 264 | 3,836 | 31,093 |
| 1956 | 17 | 1,036 | .50 | 30.50 | 15,595 | 268 | 4,178 | 33,963 |
| 1957 | 9 | 1,112 | .24 | 29.36 | 17,921 | 262 | 4,691 | 37,877 |
| 1958 | 15 | 955 | .43 | 27.56 | 17,820 | 239 | 4,258 | 34,648 |
| 1959 | 11 | 1,072 | .30 | 29.50 | 18,765 | 239 | 4,488 | 36,334 |
| 1960 | 19 | 1,056 | .52 | 28.69 | 18,653 | 242 | 4,515 | 36,805 |
| 1961 | 15 | 861 | .42 | 24.24 | 18,281 | 238 | 4,347 | 35,517 |
| 1962 | 14 | 944 | .43 | 29.06 | 16,917 | 235 | 3,979 | 32,484 |
| 1963 | 31 | 857 | .95 | 26.34 | 15,570 | 256 | 3,988 | 32,539 |
| 1964 | 18 | 906 | .50 | 25.18 | 17,087 | 259 | 4,420 | 35,977 |
| 1965 | 21 | 989 | .56 | 26.19 | 17,214 | 268 | 4,612 | 37,760 |
| At Mills | | | | | | | | |
| 1955 | 3 | 451 | 0.15 | 22.73 | 8,723 | 283 | 2,467 | 19,843 |
| 1956 4/ | 7 | 1,157 | .17 | 28.44 | 17,585 | 288 | 5,056 | 40,675 |
| 1957 | 10 | 1,512 | .17 | 25.30 | 27,081 | 274 | 7,415 | 59,765 |
| 1958 | 9 | 1,490 | .13 | 20.94 | 32,401 | 272 | 8,809 | 71,161 |
| 1959 | 11 | 2,156 | .12 | 23.77 | 40,800 | 274 | 11,195 | 90,706 |
| 1960 | 13 | 1,794 | .15 | 20.77 | 39,568 | 270 | 10,679 | 86,386 |
| 1961 | 6 | 1,680 | .07 | 20.02 | 39,031 | 268 | 10,471 | 83,925 |
| 1962 | 9 | 1,383 | .12 | 18.53 | 34,900 | 261 | 9,112 | 74,621 |
| 1963 | 2 | 1,476 | .03 | 19.44 | 33,732 | 280 | 9,452 | 75,944 |
| 1964 | 6 | 1,580 | .08 | 22.11 | 31,967 | 279 | 8,914 | 71,461 |
| 1965 | 10 | 1,483 | .14 | 20.89 | 31,215 | 283 | 8,819 | 70,975 |

1/ Mill data, except for clay, first compiled for 1955.
2/ Fluorspar for Illinois and Kentucky previously included with lead-zinc for Mississippi Valley States, now included with nonmetal mines.
3/ Includes clay mine data not compiled before 1955.
4/ Clay mill data included beginning with 1956.

APPENDIX A.- STATISTICAL TABLES FOR THE NONMETALLIC INDUSTRY, 1965

TABLE A-1. - Injury experience by degree and employment data on nonmetal mines and mills in the United States, by general work location, 1965

| General work location | Injuries | | | | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Active operations | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Fatal | Non-fatal | All injuries | Fatal | Non-fatal | All injuries | | | | | |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | | | | |
| Underground mines: | | | | | | | | | | | | | | | | | |
| Underground | 11 | 2 | 15 | 473 | 490 | 501 | 1.04 | 46.54 | 47.58 | 6,268 | 3,148 | 9,416 | 202 | 4,493 | 290 | 1,304,380 | 10,529,702 |
| Surface | 1 | - | 1 | 50 | 51 | 52 | .31 | 15.58 | 15.89 | 1,833 | 420 | 2,254 | - | 1,335 | 305 | 407,664 | 3,272,844 |
| Total or average | 12 | 2 | 16 | 523 | 541 | 553 | .87 | 39.20 | 40.07 | 5,216 | 2,501 | 7,718 | 202 | 5,828 | 294 | 1,712,044 | 13,802,546 |
| Open pit mines | 7 | 2 | 10 | 369 | 381 | 388 | .38 | 20.60 | 20.98 | 2,271 | 1,485 | 3,756 | 1,804 | 9,568 | 238 | 2,279,270 | 18,497,594 |
| Other surface mining | 2 | - | 3 | 64 | 67 | 69 | .37 | 12.27 | 12.64 | 2,198 | 479 | 2,677 | 161 | 1,818 | 341 | 620,332 | 5,459,976 |
| Total or average, mining | 21 | 4 | 29 | 956 | 989 | 1,010 | .56 | 26.19 | 26.75 | 3,337 | 1,711 | 5,048 | 2,167 | 17,214 | 268 | 4,611,646 | 37,760,116 |
| Mills | 10 | 2 | 40 | 1,441 | 1,483 | 1,493 | .14 | 20.89 | 21.04 | 845 | 1,141 | 1,987 | 845 | 31,215 | 283 | 8,818,832 | 70,974,920 |
| Grand total or average | 31 | 6 | 69 | 2,397 | 2,472 | 2,503 | .29 | 22.73 | 23.02 | 1,711 | 1,339 | 3,050 | 3,012 | 48,429 | 277 | 13,430,478 | 108,735,036 |

TABLE A-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965

| General work location and detailed cause by injury | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| UNDERGROUND MINES | | | | | | | | | |
| Underground: | | | | | | | | | |
| Falls of roof or back: | | | | | | | | | |
| While mining | 1 | 1 | 1 | 12 | 14 | 15 | - | 42 | 837 |
| While loading | - | - | - | 3 | 3 | 3 | - | 35 | 35 |
| While testing or barring down back | 1 | - | - | 10 | 10 | 11 | - | 57 | 597 |
| While setting or removing timber or other support | 1 | - | - | - | - | 1 | - | - | 6,000 |
| All other | 1 | - | - | 11 | 11 | 12 | - | 10 | 509 |
| Falls of face or side: | | | | | | | | | |
| While mining | - | - | - | 10 | 10 | 10 | - | 32 | 32 |
| While testing or barring down back | - | - | - | 3 | 3 | 3 | - | 25 | 25 |
| While setting or removing timber or other support | - | - | - | 2 | 2 | 2 | - | 2 | 2 |
| While moving machinery | - | - | - | 1 | 1 | 1 | - | 61 | 61 |
| All other | 1 | - | - | 2 | 2 | 3 | - | 72 | 2,048 |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 6 | 6 | 6 | - | 43 | 43 |
| From car, bin, platform, or chute | - | - | - | 9 | 9 | 9 | - | 27 | 27 |
| Falling cage | - | - | - | 3 | 3 | 3 | - | 7 | 7 |
| Falling equipment or machinery under repair | 1 | - | - | - | - | 1 | - | - | 6,000 |
| From stockpile, dump, or gob | 1 | - | - | 7 | 7 | 8 | - | 12 | 760 |
| All other | - | - | - | 6 | 6 | 6 | - | 23 | 23 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | - | 13 | 13 | 13 | - | 12 | 12 |
| Caused by handtool slipping or breaking | - | - | - | 1 | 1 | 1 | - | 27 | 27 |
| While operating or moving machinery | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| All other | - | - | - | 11 | 11 | 11 | - | 10 | 10 |
| From an elevation: | | | | | | | | | |
| While escaping another hazard | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| While handling material | - | - | - | 8 | 8 | 8 | - | 17 | 17 |
| While operating or moving machinery | - | - | - | 2 | 2 | 2 | - | 6 | 6 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 3 | 3 | 3 | - | 26 | 26 |
| All other | - | - | - | 12 | 12 | 12 | - | 30 | 30 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 25 | 25 | 25 | - | 22 | 22 |
| Ore, valuable mineral | - | - | 1 | 9 | 10 | 10 | 75 | 12 | 18 |
| Rail | - | - | 1 | 6 | 7 | 7 | 450 | 15 | 77 |
| Wire or wire rope | - | - | - | 7 | 7 | 7 | - | 40 | 40 |
| Conveyor pan | - | - | 1 | 1 | 2 | 2 | 50 | 10 | 30 |
| Flying particle while loading car | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Flying particle while handling material | - | - | - | 2 | 2 | 2 | - | 3 | 3 |
| All other | - | - | 1 | 50 | 51 | 51 | 300 | 16 | 22 |
| Handtools: | | | | | | | | | |
| Pick | - | - | - | 2 | 2 | 2 | - | 4 | 4 |
| Axe, hatchet, or adz | - | - | 1 | 3 | 4 | 4 | 120 | 12 | 39 |
| Hammer or sledge | - | - | - | 4 | 4 | 4 | - | 26 | 26 |
| Crowbar or bar | - | - | - | 8 | 8 | 8 | - | 9 | 9 |
| Flying particle from tool or object worked on | - | - | - | 5 | 5 | 5 | - | 12 | 12 |
| All other | - | - | - | 9 | 9 | 9 | - | 22 | 22 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | |
| Stepping on sharp object | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Stepping on loose object | - | - | - | 11 | 11 | 11 | - | 20 | 20 |
| Striking or bumping against objects | - | - | - | 5 | 5 | 5 | - | 7 | 7 |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | |
| Coupling or uncoupling | - | - | 1 | 1 | 2 | 2 | 450 | 31 | 241 |
| Pulling, pushing, or dropping | - | - | - | 1 | 1 | 1 | - | 20 | 20 |
| All other | - | - | - | 1 | 1 | 1 | - | 182 | 182 |
| Squeezed between cage, car or motor, and other object: | | | | | | | | | |
| Switching, spragging, blocking, or braking | - | - | 1 | - | 1 | 1 | 900 | - | 900 |
| Operating or riding | - | - | - | 7 | 7 | 7 | - | 54 | 54 |
| All other | - | - | - | 6 | 6 | 6 | - | 22 | 22 |
| Derailment | - | - | 1 | - | 1 | 1 | 1,500 | - | 1,500 |
| Rerailing | - | - | - | 6 | 6 | 6 | - | 52 | 52 |
| Collision (while under control) | - | - | - | 1 | 1 | 1 | - | 95 | 95 |
| Falling, slipping, or jumping into or from | - | - | 1 | 5 | 6 | 6 | 240 | 7 | 46 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Struck or run over | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | 1 | - | 1 | 2 | 3 | 4 | 315 | 5 | 1,581 |
| All other | - | - | - | 5 | 5 | 5 | - | 38 | 38 |
| Railroad cars and locomotives | - | - | - | 5 | 5 | 5 | - | 28 | 28 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 1 | 3 | 4 | 4 | 450 | 3 | 115 |
| All other | - | - | - | 13 | 13 | 13 | - | 30 | 30 |
| Water transportation: Fall of person | - | - | - | 1 | 1 | 1 | - | 330 | 330 |
| Miscellaneous haulage: | | | | | | | | | |
| Rope or cable on haulage | - | - | - | 4 | 4 | 4 | - | 29 | 29 |
| Flying particle | - | - | - | 1 | 1 | 1 | - | 78 | 78 |
| All other | - | - | - | 10 | 10 | 10 | - | 22 | 22 |
| Explosives: | | | | | | | | | |
| Premature shot or blast | - | 1 | - | - | 1 | 1 | - | - | 6,000 |
| Flying fragments | - | - | - | 1 | 1 | 1 | - | 10 | 10 |
| Suffocation from smoke | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Cap or detonator | - | - | - | 2 | 2 | 2 | - | 12 | 12 |
| Electricity: | | | | | | | | | |
| Trolley wire or pole | - | - | - | 2 | 2 | 2 | - | 7 | 7 |
| Power or lighting circuit | - | - | - | 2 | 2 | 2 | - | 6 | 6 |

TABLE A-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause of injury | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| UNDERGROUND MINES - Continued | | | | | | | | | |
| Underground - Continued | | | | | | | | | |
| Electricity - Continued | | | | | | | | | |
| Locomotive or shuttle car | - | - | - | 1 | 1 | 1 | - | 21 | 21 |
| Cut-out switch or junction box | - | - | - | 2 | 2 | 2 | - | 54 | 54 |
| Cable, cable arc, or blowup | - | - | - | 4 | 4 | 4 | - | 24 | 24 |
| All other | 1 | - | - | 4 | 4 | 5 | - | 4 | 1,203 |
| Machinery: | | | | | | | | | |
| While operating (cutter bar, chain, bit) | - | - | - | 2 | 2 | 2 | - | 62 | 62 |
| Belt conveyor | 1 | - | - | 2 | 2 | 3 | - | 33 | 2,022 |
| Mucking machine, mechanical loader | - | - | 1 | 12 | 13 | 13 | 150 | 18 | 28 |
| Power drill; rotary or percussive (except rock bolting) | - | - | 1 | 23 | 24 | 24 | 300 | 20 | 32 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | 6 | 6 | 6 | - | 28 | 28 |
| Stationary machinery | - | - | 1 | - | 1 | 1 | 4,500 | - | 4,500 |
| While moving any machine except mining or loading | - | - | - | 4 | 4 | 4 | - | 72 | 72 |
| Particle set in motion by machinery (except rock bolting) | - | - | - | 5 | 5 | 5 | - | 7 | 7 |
| All other | - | - | - | 8 | 8 | 8 | - | 28 | 28 |
| Suffocation (no flame or smoldering): Foreign gas | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Mine fires or suffocation from fires | - | - | - | 6 | 6 | 6 | - | 3 | 3 |
| Miscellaneous causes: | | | | | | | | | |
| Irritation or burn from caustic or acid | - | - | - | 2 | 2 | 2 | - | 12 | 12 |
| Burn from controlled fire | - | - | - | 1 | 1 | 1 | - | 8 | 8 |
| All other | - | - | - | 12 | 12 | 12 | - | 40 | 40 |
| Total or average | 10 | 2 | 15 | 462 | 479 | 489 | 657 | 24 | 190 |
| Shaft and slope: | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 1 | 1 | 1 | - | 5 | 5 |
| From car, bin, platform, or chute | - | - | - | 3 | 3 | 3 | - | 11 | 11 |
| From stockpile, dump, or gob | - | - | - | 1 | 1 | 1 | - | 13 | 13 |
| All other | - | - | - | 3 | 3 | 3 | - | 2 | 2 |
| Slips or falls of persons: | | | | | | | | | |
| On same level | 1 | - | - | - | - | 1 | - | - | 6,000 |
| From an elevation: Down shaft or slope | - | - | - | 1 | 1 | 1 | - | 33 | 33 |
| Striking or bumping against objects | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Miscellaneous causes: Irritation or burn from caustic or acid | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Total or average | 1 | - | - | 11 | 11 | 12 | - | 9 | 508 |
| Total or average, underground | 11 | 2 | 15 | 473 | 490 | 501 | 657 | 24 | 198 |
| Surface: | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| All other | - | - | - | 2 | 2 | 2 | - | 11 | 11 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| While operating or moving machinery | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| All other | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| From an elevation | - | - | - | 3 | 3 | 3 | - | 94 | 94 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 5 | 5 | 5 | - | 11 | 11 |
| Ore, valuable mineral | - | - | - | 3 | 3 | 3 | - | 22 | 22 |
| Flying particle while handling material | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| All other | - | - | - | 15 | 15 | 15 | - | 11 | 11 |
| Handtools | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Stepping or kneeling on sharp or loose objects: Stepping on loose object | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Striking or bumping against objects | - | - | - | 2 | 2 | 2 | - | 26 | 26 |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between | - | - | - | 1 | 1 | 1 | - | 46 | 46 |
| Rerailing | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Railroad cars and locomotives | - | - | - | 1 | 1 | 1 | - | 53 | 53 |
| Automobiles, gasoline or diesel trucks | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Water transporation | - | - | - | 1 | 1 | 1 | - | 5 | 5 |
| Miscellaneous haulage: Animal on haulage | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Electricity: Cable, cable arc, or blowup | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | - | 1 | 1 | 1 | - | 51 | 51 |
| Power shovel, dragline, bulldozer, etc. | 1 | - | - | 2 | 2 | 3 | - | 173 | 2,115 |
| Stationary machinery | - | - | 1 | - | 1 | 1 | 150 | - | 150 |
| While moving any machine except mining or loading | - | - | - | 1 | 1 | 1 | - | 17 | 17 |
| Particle set in motion by machinery | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| All other | - | - | - | 1 | 1 | 1 | - | 32 | 32 |
| Total or average | 1 | - | 1 | 50 | 51 | 52 | 150 | 25 | 142 |
| Total or average, underground mines | 12 | 2 | 16 | 523 | 541 | 553 | 625 | 24 | 193 |

TABLE A-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause of injury | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| OPEN PIT MINES | | | | | | | | | |
| Falls of face or side | - | - | - | 1 | 1 | 1 | - | 9 | 9 |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 3 | 3 | 3 | - | 11 | 11 |
| Dropped or thrown by coworker | - | - | - | 6 | 6 | 6 | - | 19 | 19 |
| From car, bin, platform, or chute | 1 | - | - | 2 | 2 | 3 | - | 32 | 2,021 |
| All other | - | - | - | 6 | 6 | 6 | - | 13 | 13 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | - | 8 | 8 | 8 | - | 23 | 23 |
| While operating or moving machinery | - | - | - | 2 | 2 | 2 | - | 23 | 23 |
| All other | - | - | - | 15 | 15 | 15 | - | 23 | 23 |
| From an elevation: | | | | | | | | | |
| While escaping another hazard | - | - | - | 3 | 3 | 3 | - | 34 | 34 |
| While handling material | - | - | - | 6 | 6 | 6 | - | 12 | 12 |
| While operating or moving machinery | - | - | - | 5 | 5 | 5 | - | 9 | 9 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 8 | 8 | 8 | - | 27 | 27 |
| All other | - | - | - | 6 | 6 | 6 | - | 26 | 26 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 7 | 7 | 7 | - | 24 | 24 |
| Ore, valuable mineral | - | - | - | 4 | 4 | 4 | - | 9 | 9 |
| Rail | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Wire or wire rope | - | - | 1 | 15 | 16 | 16 | 300 | 29 | 46 |
| Flying particle while loading car | - | - | - | 4 | 4 | 4 | - | 9 | 9 |
| Flying particle while handling material | - | - | 1 | 13 | 14 | 14 | 1,800 | 17 | 144 |
| All other | - | - | 2 | 76 | 78 | 78 | 125 | 15 | 16 |
| Handtools: | | | | | | | | | |
| Hammer or sledge | - | - | - | 3 | 3 | 3 | - | 13 | 13 |
| Crowbar or bar | - | - | 1 | 5 | 6 | 6 | 540 | 19 | 106 |
| Flying particle from tool or object worked on | - | - | - | 4 | 4 | 4 | - | 12 | 12 |
| All other | - | - | - | 6 | 6 | 6 | - | 13 | 13 |
| Stepping or kneeling on sharp or loose objects: Stepping on loose object | - | - | - | 3 | 3 | 3 | - | 5 | 5 |
| Striking or bumping against objects | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Haulage: | | | | | | | | | |
| Skips, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | |
| Pulling, pushing, or dropping | - | - | - | 2 | 2 | 2 | - | 12 | 12 |
| All other | - | - | - | 2 | 2 | 2 | - | 11 | 11 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Struck or run over | - | - | - | 1 | 1 | 1 | - | 75 | 75 |
| Railroad cars and locomotives | 1 | - | 1 | 10 | 11 | 12 | 1,000 | 9 | 591 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 13 | 13 | 13 | - | 14 | 14 |
| All other | 1 | - | 1 | 14 | 15 | 16 | 440 | 15 | 416 |
| Miscellaneous haulage: Rope or cable on haulage | - | - | - | 2 | 2 | 2 | - | 28 | 28 |
| Explosives: | | | | | | | | | |
| Premature shot or blast | - | - | 1 | 1 | 2 | 2 | 1,800 | 68 | 934 |
| Cap or detonator | - | - | 1 | - | 1 | 1 | 1,620 | - | 1,620 |
| Electricity: Cut-out switch or junction box | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | - | 5 | 5 | 5 | - | 18 | 18 |
| Chain, bucket, shaker, or screw conveyor | - | - | - | 2 | 2 | 2 | - | 13 | 13 |
| Mucking machine, mechanical loader | 1 | - | - | 10 | 10 | 11 | - | 16 | 560 |
| Power drill; rotary or percussive | - | - | - | 13 | 13 | 13 | - | 73 | 73 |
| Power shovel, dragline, bulldozer, etc. | 3 | - | 1 | 24 | 25 | 28 | 100 | 27 | 670 |
| Stationary machinery | - | - | - | 12 | 12 | 12 | - | 36 | 36 |
| While moving any machine except mining or loading | - | - | - | 8 | 8 | 8 | - | 21 | 21 |
| Particle set in motion by machinery | - | - | - | 6 | 6 | 6 | - | 12 | 12 |
| All other | - | - | - | 4 | 4 | 4 | - | 35 | 35 |
| Mine fires or suffocation from fires: Oil, gasoline, flammable liquid | - | - | - | 1 | 1 | 1 | - | 63 | 63 |
| Miscellaneous causes: | | | | | | | | | |
| Flying particle from draft or wind | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Acetylene or electric welding or cutting | - | - | - | 6 | 6 | 6 | - | 10 | 10 |
| Irritation or burn from caustic or acid | - | - | - | 3 | 3 | 3 | - | 14 | 14 |
| Burn from controlled fire | - | - | - | 7 | 7 | 7 | - | 18 | 18 |
| All other | - | - | - | 8 | 8 | 8 | - | 33 | 33 |
| Pneumoconiosis | - | 2 | - | - | 2 | 2 | - | - | 6,000 |
| Total or average | 7 | 2 | 10 | 369 | 381 | 388 | 773 | 21 | 179 |
| OTHER SURFACE MINING | | | | | | | | | |
| Sliding or falling material or objects: Dropped or thrown by coworker | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| All other | - | - | 1 | 2 | 3 | 3 | 75 | 3 | 27 |
| From an elevation: | | | | | | | | | |
| While handling material | - | - | - | 2 | 2 | 2 | - | 13 | 13 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 1 | 1 | 1 | - | 16 | 16 |
| All other | 1 | - | - | 8 | 8 | 9 | - | 32 | 695 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 2 | 2 | 2 | - | 10 | 10 |
| Ore, valuable mineral | - | - | - | 2 | 2 | 2 | - | 22 | 22 |
| Wire or wire rope | - | - | - | 1 | 1 | 1 | - | 5 | 5 |
| All other | - | - | - | 21 | 21 | 21 | - | 46 | 46 |

TABLE A-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued



| General work location and detailed cause of injury | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| OTHER SURFACE MINING - Continued | | | | | | | | | |
| Handtools: | | | | | | | | | |
| Flying particle from tool or object worked on | - | - | - | 1 | 1 | 1 | - | 22 | 22 |
| All other | - | - | 1 | - | 1 | 1 | 60 | - | 60 |
| Stepping or kneeling on sharp or loose objects: Stepping on sharp object | - | - | - | 1 | 1 | 1 | - | 8 | 8 |
| Haulage: | | | | | | | | | |
| Shuttle cars, transloaders, and small mobile trucks | - | - | - | 1 | 1 | 1 | - | 7 | 7 |
| Railroad cars and locomotives | - | - | - | 1 | 1 | 1 | - | 15 | 15 |
| Automobiles, gasoline or diesel trucks | - | - | - | 1 | 1 | 1 | - | 75 | 75 |
| Water transportation: | | | | | | | | | |
| Fall of person | 1 | - | - | 1 | 1 | 2 | - | 5 | 3,003 |
| All other | - | - | - | 1 | 1 | 1 | - | 90 | 90 |
| Machinery: | | | | | | | | | |
| Power drill; rotary or percussive | - | - | 1 | 2 | 3 | 3 | 400 | 41 | 161 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | 1 | 1 | 1 | - | 92 | 92 |
| Stationary machinery | - | - | - | 4 | 4 | 4 | - | 36 | 36 |
| Particle set in motion by machinery | - | - | - | 1 | 1 | 1 | - | 5 | 5 |
| Miscellaneous causes: | | | | | | | | | |
| Flying particle from draft or wind | - | - | - | 2 | 2 | 2 | - | 9 | 9 |
| Acetylene or electric welding or cutting | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Irritation or burn from caustic or acid | - | - | - | 1 | 1 | 1 | - | 60 | 60 |
| Burn from controlled fire | - | - | - | 3 | 3 | 3 | - | 19 | 19 |
| All other | - | - | - | 1 | 1 | 1 | - | 63 | 63 |
| Total or average | 2 | - | 3 | 64 | 67 | 69 | 178 | 33 | 212 |
| Total or average, mining | 21 | 4 | 29 | 956 | 989 | 1,010 | 650 | 23 | 189 |
| MILLS | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Dropped or thrown by coworker | - | - | 1 | 5 | 6 | 6 | 1,440 | 22 | 258 |
| From car, bin, platform, or chute | - | - | - | 20 | 20 | 20 | - | 16 | 16 |
| Falling equipment or machinery under repair | - | - | - | 4 | 4 | 4 | - | 25 | 25 |
| All other | - | - | - | 22 | 22 | 22 | - | 8 | 8 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | 1 | 59 | 60 | 60 | 400 | 24 | 31 |
| Caused by handtool slipping or breaking | - | - | - | 2 | 2 | 2 | - | 24 | 24 |
| While operating or moving machinery | - | - | - | 3 | 3 | 3 | - | 13 | 13 |
| All other | - | - | - | 65 | 65 | 65 | - | 19 | 19 |
| From an elevation: | | | | | | | | | |
| While escaping another hazard | - | - | - | 1 | 1 | 1 | - | 20 | 20 |
| While handling material | - | - | - | 13 | 13 | 13 | - | 44 | 44 |
| Caused by handtool slipping or breaking | - | - | - | 2 | 2 | 2 | - | 31 | 31 |
| Caused by electric current | - | - | - | 2 | 2 | 2 | - | 47 | 47 |
| While operating or moving machinery | - | - | - | 11 | 11 | 11 | - | 18 | 18 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 15 | 15 | 15 | - | 87 | 87 |
| All other | 2 | - | 3 | 57 | 60 | 62 | 1,040 | 26 | 268 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 32 | 32 | 32 | - | 13 | 13 |
| Ore, valuable mineral | 2 | - | - | 23 | 23 | 25 | - | 19 | 497 |
| Rock or waste | - | - | - | 6 | 6 | 6 | - | 17 | 17 |
| Rail | - | - | - | 7 | 7 | 7 | - | 12 | 12 |
| Wire or wire rope | - | - | - | 21 | 21 | 21 | - | 12 | 12 |
| Flying particle while loading car | - | - | - | 5 | 5 | 5 | - | 9 | 9 |
| Flying particle while handling material | - | - | 1 | 22 | 23 | 23 | 1,800 | 8 | 86 |
| All other | - | - | 5 | 515 | 520 | 520 | 428 | 17 | 21 |
| Handtools: | | | | | | | | | |
| Axe, hatchet, or adz | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| Hammer or sledge | - | - | - | 12 | 12 | 12 | - | 12 | 12 |
| Crowbar or bar | - | - | - | 16 | 16 | 16 | - | 23 | 23 |
| Shovel | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| In hand of fellow worker | - | - | - | 2 | 2 | 2 | - | 34 | 34 |
| Flying particle from tool or object worked on | - | - | 1 | 5 | 6 | 6 | 1,800 | 20 | 317 |
| All other | - | - | 1 | 28 | 29 | 29 | 300 | 22 | 32 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | |
| Stepping on sharp object | - | - | - | 11 | 11 | 11 | - | 8 | 8 |
| Stepping on loose object | - | - | - | 31 | 31 | 31 | - | 17 | 17 |
| While working on hands and knees | - | - | - | 1 | 1 | 1 | - | 63 | 63 |
| Striking or bumping against objects | - | - | - | 14 | 14 | 14 | - | 10 | 10 |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | |
| Switching, spragging, blocking, or braking | - | - | - | 1 | 1 | 1 | - | 54 | 54 |
| Pulling, pushing, or dropping | - | - | - | 3 | 3 | 3 | - | 46 | 46 |
| All other | 1 | 1 | - | 2 | 3 | 4 | - | 149 | 3,074 |
| Squeezed between cage, car or motor, and other object | - | - | - | 1 | 1 | 1 | - | 10 | 10 |
| Falling, slipping, or jumping into or from | - | - | - | 1 | 1 | 1 | - | 71 | 71 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Struck or run over | - | - | - | 11 | 11 | 11 | - | 21 | 21 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | 1 | 2 | 3 | 3 | 150 | 7 | 54 |
| All other | - | - | - | 15 | 15 | 15 | - | 41 | 41 |
| Railroad cars and locomotives | 1 | - | - | 34 | 34 | 35 | - | 32 | 203 |

TABLE A-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause of injury | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| MILLS - Continued | | | | | | | | | |
| Haulage - Continued | | | | | | | | | |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 18 | 18 | 18 | - | 24 | 24 |
| All other | 2 | - | - | 15 | 15 | 17 | - | 28 | 731 |
| Water transportation | - | - | - | 2 | 2 | 2 | - | 18 | 18 |
| Miscellaneous haulage: | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | - | - | - | 1 | 1 | 1 | - | 36 | 36 |
| Rope or cable on haulage | - | - | 2 | 13 | 15 | 15 | 2,400 | 22 | 339 |
| Animal on haulage | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Slip or strain from moving car by hand | - | - | - | 7 | 7 | 7 | - | 31 | 31 |
| Riding or getting on or off conveyor belt | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Flying particle | - | - | - | 6 | 6 | 6 | - | 4 | 4 |
| All other | - | - | 1 | 9 | 10 | 10 | 800 | 30 | 107 |
| Explosions of gas or dust | - | - | - | 1 | 1 | 1 | - | 90 | 90 |
| Electricity: | | | | | | | | | |
| Transformer, generator, or stationary motor | - | - | - | 1 | 1 | 1 | - | 8 | 8 |
| Cut-out switch or junction box | - | - | - | 3 | 3 | 3 | - | 21 | 21 |
| All other | 1 | - | - | 1 | 1 | 2 | - | 2 | 3,001 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | 2 | 27 | 29 | 29 | 400 | 45 | 70 |
| Chain, bucket, shaker, or screw conveyor | - | - | 3 | 7 | 10 | 10 | 1,367 | 50 | 445 |
| Mucking machine, mechanical loader | - | - | - | 1 | 1 | 1 | - | 9 | 9 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | 10 | 10 | 10 | - | 20 | 20 |
| Stationary machinery | - | - | 15 | 45 | 60 | 60 | 1,101 | 28 | 296 |
| While moving any machine except mining or loading | - | - | 1 | 17 | 18 | 18 | 175 | 24 | 33 |
| Particle set in motion by machinery | - | - | 1 | 13 | 14 | 14 | 900 | 5 | 69 |
| All other | - | - | 1 | 9 | 10 | 10 | 200 | 15 | 34 |
| Suffocation (no flame or smoldering): Foreign gas | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Fires or suffocation from fires: Oil, gasoline, flammable liquid | - | - | - | 2 | 2 | 2 | - | 1 | 1 |
| Miscellaneous causes: | | | | | | | | | |
| Flying particle from draft or wind | - | - | - | 12 | 12 | 12 | - | 5 | 5 |
| Acetylene or electric welding or cutting | - | - | - | 19 | 19 | 19 | - | 6 | 6 |
| Irritation or burn from caustic or acid | 1 | - | - | 24 | 24 | 25 | - | 19 | 258 |
| Burn from controlled fire | - | - | - | 30 | 30 | 30 | - | 25 | 25 |
| All other | - | - | - | 40 | 40 | 40 | - | 18 | 18 |
| Pneumoconiosis | - | 1 | - | - | 1 | 1 | - | - | 6,000 |
| Total or average, mills | 10 | 2 | 40 | 1,441 | 1,483 | 1,493 | 986 | 21 | 94 |
| Grand total or average | 31 | 6 | 69 | 2,397 | 2,472 | 2,503 | 836 | 22 | 132 |

TABLE A-3. - Fatal injuries and distribution by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965

| General work location and detailed cause | Injuries: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Total | Percentage distribution |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | |
| Falls of roof or back: | | | | | | | | | | | |
| While mining | - | - | 1 | - | - | - | - | - | - | 1 | 9.09 |
| While testing or barring down back | - | - | - | - | - | - | - | - | 1 | 1 | 9.09 |
| While setting or removing timber or other support | - | - | 1 | - | - | - | - | - | - | 1 | 9.09 |
| All other | - | - | - | - | - | - | - | - | 1 | 1 | 9.09 |
| Falls of face or side | 1 | - | - | - | - | - | - | - | - | 1 | 9.09 |
| Sliding or falling material or objects: | | | | | | | | | | | |
| Falling equipment or machinery under repair | 1 | - | - | - | - | - | - | - | - | 1 | 9.09 |
| From stockpile, dump, or gob | - | - | - | - | - | - | - | - | 1 | 1 | 9.09 |
| Slips or falls of persons: | | | | | | | | | | | |
| On same level | 1 | - | - | - | - | - | - | - | - | 1 | 9.09 |
| Haulage: | | | | | | | | | | | |
| Shuttle cars, transloaders, and small mobile trucks: Squeezed between shuttle car, transloader, or small mobile truck, and other object | 1 | - | - | - | - | - | - | - | - | 1 | 9.09 |
| Electricity | - | - | - | - | - | - | - | - | 1 | 1 | 9.09 |
| Machinery: Belt conveyor | - | - | - | - | - | - | - | - | 1 | 1 | 9.09 |
| Total | 4 | - | 2 | - | - | - | - | - | 5 | 11 | - |
| Percentage distribution | 36.36 | - | 18.18 | - | - | - | - | - | 45.46 | - | - |
| Surface at underground: | | | | | | | | | | | |
| Machinery: Power shovel, dragline, bulldozer, etc. | 1 | - | - | - | - | - | - | - | - | 1 | 100.00 |
| Total | 1 | - | - | - | - | - | - | - | - | 1 | - |
| Percentage distribution | 100.00 | - | - | - | - | - | - | - | - | - | - |
| Total, underground mines | 5 | - | 2 | - | - | - | - | - | 5 | 12 | - |
| Percentage distribution | 41.67 | - | 16.66 | - | - | - | - | - | 41.67 | - | - |
| ALL SURFACE MINES | | | | | | | | | | | |
| Sliding or falling material or objects: From car, bin, platform, or chute | - | - | - | - | - | - | - | - | 1 | 1 | 11.11 |
| Slips or falls of persons: | | | | | | | | | | | |
| From an elevation | - | - | - | - | - | - | - | - | 1 | 1 | 11.11 |
| Haulage: | | | | | | | | | | | |
| Railroad cars and locomotives | - | - | - | - | - | - | - | - | 1 | 1 | 11.11 |
| Automobiles, gasoline or diesel trucks | 1 | - | - | - | - | - | - | - | - | 1 | 11.11 |
| Water transportation: Fall of person | - | - | - | - | - | - | - | - | 1 | 1 | 11.11 |
| Machinery: | | | | | | | | | | | |
| Mucking machine, mechanical loader | - | - | - | - | - | - | - | - | 1 | 1 | 11.11 |
| Power shovel, dragline, bulldozer, etc. | 1 | - | - | - | - | - | - | - | 2 | 3 | 33.34 |
| Total, surface | 2 | - | - | - | - | - | - | - | 7 | 9 | - |
| Percentage distribution | 22.22 | - | - | - | - | - | - | - | 77.78 | - | - |
| Total, mining | 7 | - | 2 | - | - | - | - | - | 12 | 21 | - |
| Percentage distribution | 33.33 | - | 9.53 | - | - | - | - | - | 57.14 | - | - |
| MILLS | | | | | | | | | | | |
| Slips or falls of persons: | | | | | | | | | | | |
| From an elevation | 2 | - | - | - | - | - | - | - | - | 2 | 20.00 |
| Handling material: Ore, valuable mineral | - | - | 1 | - | - | - | - | - | 1 | 2 | 20.00 |
| Haulage: | | | | | | | | | | | |
| Cages, cars, or motors | - | - | - | - | - | - | - | - | 1 | 1 | 10.00 |
| Railroad cars and locomotives | - | - | - | - | - | - | - | - | 1 | 1 | 10.00 |
| Automobiles, gasoline or diesel trucks | - | - | 1 | - | - | - | - | - | 1 | 2 | 20.00 |
| Electricity | - | - | 1 | - | - | - | - | - | - | 1 | 10.00 |
| Miscellaneous causes: Irritation or burn from caustic or acid | - | - | - | - | - | - | - | - | 1 | 1 | 10.00 |
| Total, mills | 2 | - | 3 | - | - | - | - | - | 5 | 10 | - |
| Percentage distribution | 20.00 | - | 30.00 | - | - | - | - | - | 50.00 | - | - |
| Grand total | 9 | - | 5 | - | - | - | - | - | 17 | 31 | - |
| Percentage distribution | 29.03 | - | 16.13 | - | - | - | - | - | 54.84 | - | - |

TABLE A-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965

| General work location and detailed cause | Injuries: Head, face, neck | Injuries: Eye | Injuries: Trunk | Injuries: Hernia | Injuries: Upper extremities | Injuries: Hand and fingers | Injuries: Lower extremities | Injuries: Foot and toes | Injuries: General (multiple) | Injuries: Not stated | Injuries: Total | Percentage distribution | Average severity: Head, face, neck | Average severity: Eye | Average severity: Trunk | Average severity: Hernia | Average severity: Upper extremities | Average severity: Hand and fingers | Average severity: Lower extremities | Average severity: Foot and toes | Average severity: General (multiple) | Average severity: Not stated | Average severity: Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES | | | | | | | | | | | | | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | | | | | | | | | | | | | |
| Falls of roof or back: | | | | | | | | | | | | | | | | | | | | | | | |
| While mining | 3 | 1 | 4 | 1 | - | 3 | - | 1 | 1 | - | 14 | 2.86 | 24 | 1 | 1,567 | 48 | - | 25 | - | 67 | 28 | - | 469 |
| While loading | - | - | 3 | - | - | - | - | - | - | - | 3 | .61 | - | - | 35 | - | - | - | - | - | - | - | 35 |
| While testing or barring down back | 1 | - | 4 | - | - | 1 | - | 3 | 1 | - | 10 | 2.04 | 10 | - | 39 | - | - | 28 | - | 124 | 1 | - | 57 |
| All other | - | - | 2 | - | - | 7 | - | 1 | 1 | - | 11 | 2.24 | - | - | 4 | - | - | 12 | - | 9 | 7 | - | 10 |
| Falls of face or side: | | | | | | | | | | | | | | | | | | | | | | | |
| While mining | - | - | 1 | - | - | 3 | 2 | 4 | - | - | 10 | 2.04 | - | - | 29 | - | - | 7 | 98 | 19 | - | - | 32 |
| While testing or barring down back | - | - | - | - | - | - | - | 3 | - | - | 3 | .61 | - | - | - | - | - | - | - | 25 | - | - | 25 |
| While setting or removing timber or other support | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .41 | - | - | 2 | - | - | - | 1 | - | - | - | 2 |
| While moving machinery | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 61 | - | - | - | - | - | - | - | 61 |
| All other | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .41 | - | - | 131 | - | - | - | 12 | - | - | - | 72 |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Timber or other support | 1 | - | 2 | - | 1 | - | 1 | 2 | - | - | 7 | 1.43 | 8 | - | 8 | - | 5 | - | 80 | 77 | - | - | 38 |
| From car, bin, platform, or chute | 1 | - | 1 | - | 1 | 2 | - | 6 | 1 | - | 12 | 2.45 | 23 | - | 4 | - | 2 | 84 | - | 10 | 27 | - | 23 |
| Falling cage | - | - | 2 | - | - | - | - | 1 | - | - | 3 | .61 | - | - | 3 | - | - | - | - | 17 | - | - | 7 |
| From stockpile, dump, or gob | - | - | - | - | - | - | 2 | 6 | - | - | 8 | 1.63 | - | - | - | - | - | - | 2 | 15 | - | - | 12 |
| All other | 2 | - | - | - | - | 3 | 1 | 3 | - | - | 9 | 1.84 | 43 | - | - | - | - | 2 | 2 | 18 | - | - | 16 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | 7 | 1 | - | 1 | 3 | 1 | - | - | 13 | 2.66 | - | - | 7 | 16 | - | 1 | 13 | 45 | - | - | 12 |
| Caused by handtool slipping or breaking | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 27 | - | - | - | - | - | - | - | 27 |
| While operating or moving machinery | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 6 | - | - | - | - | - | - | - | 6 |
| All other | - | - | 3 | - | - | - | 4 | 4 | - | - | 11 | 2.24 | - | - | 13 | - | - | - | 14 | 5 | - | - | 10 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | 1 | - | - | - | - | - | - | - | - | - | 1 | .20 | 1 | - | - | - | - | - | - | - | - | - | 1 |
| While handling material | 2 | - | 2 | - | 1 | - | 3 | - | - | - | 8 | 1.63 | 7 | - | 3 | - | 1 | - | 37 | - | - | - | 17 |
| While operating or moving machinery | - | - | - | - | - | - | - | - | 2 | - | 2 | .41 | - | - | - | - | - | - | - | - | 6 | - | 6 |
| Down shaft or slope | - | - | - | - | - | - | 1 | - | - | - | 1 | .20 | - | - | - | - | - | - | 33 | - | - | - | 33 |
| Caused by failure of scaffold, ladder, or other support | - | - | 2 | - | - | - | - | - | 1 | - | 3 | .61 | - | - | 18 | - | - | - | - | - | 42 | - | 26 |
| All other | 1 | - | 5 | - | - | - | 2 | 4 | - | - | 12 | 2.45 | 17 | - | 6 | - | - | - | 1 | 77 | - | - | 30 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | 1 | - | 10 | 2 | 2 | 5 | 2 | 2 | - | 1 | 25 | 5.10 | 4 | - | 33 | 60 | 5 | 5 | 9 | 12 | - | 18 | 22 |
| Ore, valuable mineral | - | - | 5 | - | - | 3 | 1 | 1 | - | - | 10 | 2.04 | - | - | 9 | - | - | 30 | 4 | 44 | - | - | 18 |
| Rail | 1 | - | 4 | - | - | - | 1 | 1 | - | - | 7 | 1.43 | 43 | - | 7 | - | - | - | 17 | 450 | - | - | 77 |
| Wire or wire rope | - | - | 5 | - | 1 | 1 | - | - | - | - | 7 | 1.43 | - | - | 54 | - | 5 | 5 | - | - | - | - | 40 |
| Conveyor pan | - | - | - | - | - | 1 | - | 1 | - | - | 2 | .41 | - | - | - | - | - | 50 | - | 10 | - | - | 30 |
| Flying particle while loading car | - | - | - | - | - | 1 | - | - | - | - | 1 | .20 | - | - | - | - | - | 2 | - | - | - | - | 2 |
| Flying particle while handling material | - | 2 | - | - | - | - | - | - | - | - | 2 | .41 | - | 3 | - | - | - | - | - | - | - | - | 3 |
| All other | 2 | - | 34 | 2 | - | 7 | - | 6 | - | - | 51 | 10.41 | 6 | - | 16 | 19 | - | 50 | - | 30 | - | - | 22 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Pick | - | - | - | - | - | 1 | - | 1 | - | - | 2 | .41 | - | - | - | - | - | 4 | - | 3 | - | - | 4 |
| Axe, hatchet, or adz | - | - | - | - | - | 2 | - | 2 | - | - | 4 | .82 | - | - | - | - | - | 61 | - | 18 | - | - | 39 |
| Hammer or sledge | - | - | 1 | - | - | - | 1 | 2 | - | - | 4 | .82 | - | - | 6 | - | - | - | 3 | 47 | - | - | 26 |
| Crowbar or bar | 1 | - | 2 | - | - | 4 | - | 1 | - | - | 8 | 1.63 | 2 | - | 3 | - | - | 4 | - | 50 | - | - | 9 |
| Flying particle from tool or object worked on | 1 | 3 | - | - | - | 1 | - | - | - | - | 5 | 1.02 | 2 | 19 | - | - | - | 4 | - | - | - | - | 12 |
| All other | 1 | - | 3 | 1 | - | 1 | 1 | 2 | - | - | 9 | 1.84 | 2 | - | 11 | 25 | - | 14 | 90 | 18 | - | - | 22 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on sharp object | - | - | - | - | - | - | - | 1 | - | - | 1 | .20 | - | - | - | - | - | - | - | 3 | - | - | 3 |
| Stepping on loose object | 1 | - | 1 | - | - | 1 | 3 | 5 | - | - | 11 | 2.25 | 16 | - | 36 | - | - | 2 | 30 | 16 | - | - | 20 |
| Striking or bumping against objects | 2 | - | 1 | - | 1 | 1 | 1 | - | - | - | 6 | 1.23 | 5 | - | 11 | - | 3 | 4 | 11 | - | - | - | 6 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | | | | | | | | | | | | | | | |
| Coupling or uncoupling | - | - | - | - | - | 1 | 1 | - | - | - | 2 | .41 | - | - | - | - | - | 31 | 450 | - | - | - | 241 |
| Pulling, pushing, or dropping | - | - | - | - | - | 1 | - | - | - | - | 1 | .20 | - | - | - | - | - | 20 | - | - | - | - | 20 |
| All other | - | - | - | - | - | - | 1 | - | - | - | 1 | .20 | - | - | - | - | - | - | 182 | - | - | - | 182 |

TABLE A-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause | Injuries: Head, face, neck | Eye | Trunk | Hernia | Upper extemities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | Percentage distribution | Average severity: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Haulage - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Squeezed between cage, car or motor, and other object: | | | | | | | | | | | | | | | | | | | | | | | |
| Switching, spragging, blocking, or braking | - | - | - | - | - | - | 1 | - | - | - | 1 | .20 | - | - | - | - | - | - | 900 | - | - | - | 900 |
| Operating or riding | - | - | 4 | - | 1 | 2 | - | - | - | - | 7 | 1.43 | - | - | 80 | - | 15 | 24 | - | - | - | - | 54 |
| All other | - | - | - | - | 1 | 4 | 1 | - | - | - | 6 | 1.23 | - | - | - | - | 2 | 31 | 6 | - | - | - | 22 |
| Derailment | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 1,500 | - | - | - | - | - | - | - | 1,500 |
| Rerailing | - | - | 3 | 2 | - | 1 | - | - | - | - | 6 | 1.23 | - | - | 60 | 64 | - | 3 | - | - | - | - | 52 |
| Collision (while under control) | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 95 | - | - | - | - | - | - | - | 95 |
| Falling, slipping, or jumping into or from | - | - | - | - | - | 1 | 1 | 4 | - | - | 6 | 1.23 | - | - | - | - | - | 4 | 6 | 66 | - | - | 46 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck or run over | - | - | - | - | - | - | 1 | - | - | - | 1 | .20 | - | - | - | - | - | - | 6 | - | - | - | 6 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | 1 | - | - | - | 1 | - | - | 1 | - | - | 3 | .61 | 6 | - | - | - | 315 | - | - | 3 | - | - | 108 |
| All other | 1 | - | - | - | - | - | 3 | 1 | - | - | 5 | 1.02 | 167 | - | - | - | - | - | 4 | 8 | - | - | 38 |
| Railroad cars and locomotives | - | - | 2 | - | 1 | 1 | - | 1 | - | - | 5 | 1.02 | - | - | 33 | - | 58 | 3 | - | 16 | - | - | 28 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 1 | - | - | - | 2 | 1 | - | - | 4 | .82 | - | - | 4 | - | - | - | 227 | 3 | - | - | 115 |
| All other | 2 | - | 5 | - | 1 | 1 | 2 | 1 | - | 1 | 13 | 2.66 | 16 | - | 52 | - | 1 | 6 | 22 | 6 | - | 37 | 30 |
| Water transportation: Fall of person | - | - | - | - | - | - | - | 1 | - | - | 1 | .20 | - | - | - | - | - | - | - | 330 | - | - | 330 |
| Miscellaneous haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Rope or cable on haulage | - | - | 3 | - | - | - | 1 | - | - | - | 4 | .82 | - | - | 15 | - | - | - | 69 | - | - | - | 29 |
| Flying particle | - | - | - | - | - | - | 1 | - | - | - | 1 | .20 | - | - | - | - | - | - | 78 | - | - | - | 78 |
| All other | 1 | - | 8 | - | - | 1 | - | - | - | - | 10 | 2.04 | 14 | - | 24 | - | - | 13 | - | - | - | - | 22 |
| Explosives: | | | | | | | | | | | | | | | | | | | | | | | |
| Premature shot or blast | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 6,000 | - | - | - | - | - | - | - | 6,000 |
| Flying fragments | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 10 | - | - | - | - | - | - | - | 10 |
| Suffocation from smoke | - | - | - | - | - | - | - | - | 1 | - | 1 | .20 | - | - | - | - | - | - | - | - | 1 | - | 1 |
| Cap or detonator | 1 | 1 | - | - | - | - | - | - | - | - | 2 | .41 | 22 | 2 | - | - | - | - | - | - | - | - | 12 |
| Electricity: | | | | | | | | | | | | | | | | | | | | | | | |
| Trolley wire or pole | - | 1 | - | - | - | - | - | - | 1 | - | 2 | .41 | - | 8 | - | - | - | - | - | - | 6 | - | 7 |
| Power or lighting circuit | - | 1 | - | - | - | 1 | - | - | - | - | 2 | .41 | - | 9 | - | - | - | 2 | - | - | - | - | 6 |
| Locomotive or shuttle car | - | - | - | - | - | 1 | - | - | - | - | 1 | .20 | - | - | - | - | - | 21 | - | - | - | - | 21 |
| Cut-out switch or junction box | - | - | 1 | - | - | 1 | - | - | - | - | 2 | .41 | - | - | 100 | - | - | 8 | - | - | - | - | 54 |
| Cable, cable arc, or blowup | - | - | 1 | - | - | 3 | - | - | - | - | 4 | .82 | - | - | 29 | - | - | 22 | - | - | - | - | 24 |
| All other | - | 2 | - | - | - | 1 | 1 | - | - | - | 4 | .82 | - | 3 | - | - | - | 8 | 2 | - | - | - | 4 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| While operating (cutter bar, chain, bit) | - | - | - | - | 1 | - | - | 1 | - | - | 2 | .41 | - | - | - | - | 119 | - | - | 4 | - | - | 62 |
| Belt conveyor | - | - | - | - | - | 2 | - | - | - | - | 2 | .41 | - | - | - | - | - | 33 | - | - | - | - | 33 |
| Mucking machine, mechanical loader | 1 | - | 5 | - | 2 | 1 | 1 | 3 | - | - | 13 | 2.66 | 8 | - | 25 | - | 2 | 13 | 20 | 66 | - | - | 28 |
| Power drill; rotary or percussive (except rock bolting) | 1 | - | 7 | - | 2 | 6 | 2 | 5 | - | 1 | 24 | 4.90 | 2 | - | 40 | - | 27 | 52 | 18 | 10 | - | 25 | 32 |
| Power shovel, dragline, bulldozer, etc. | - | - | 2 | - | - | 1 | 3 | - | - | - | 6 | 1.23 | - | - | 3 | - | - | 33 | 43 | - | - | - | 28 |
| Stationary machinery | - | - | - | - | - | - | 1 | - | - | - | 1 | .20 | - | - | - | - | - | - | 4,500 | - | - | - | 4,500 |
| While moving any machine except mining or loading | - | - | 2 | - | - | - | 1 | 1 | - | - | 4 | .82 | - | - | 8 | - | - | - | 192 | 81 | - | - | 72 |
| Particle set in motion by machinery (except rock bolting) | 1 | 4 | - | - | - | - | - | - | - | - | 5 | 1.02 | 8 | 7 | - | - | - | - | - | - | - | - | 7 |
| All other | 1 | - | 2 | - | - | 3 | 1 | 1 | - | - | 8 | 1.63 | 51 | - | 10 | - | - | 22 | 50 | 37 | - | - | 28 |
| Suffocation (no flame or smoldering): Foreign gas | - | - | 1 | - | - | - | - | - | - | - | 1 | .20 | - | - | 4 | - | - | - | - | - | - | - | 4 |
| Mine fires or suffocation from fires | - | - | 6 | - | - | - | - | - | - | - | 6 | 1.23 | - | - | 3 | - | - | - | - | - | - | - | 3 |
| Miscellaneous causes: | | | | | | | | | | | | | | | | | | | | | | | |
| Irritation or burn from caustic or acid | - | 1 | - | - | - | - | - | - | 2 | - | 3 | .61 | - | 1 | - | - | - | - | - | - | 12 | - | 8 |
| Burn from controlled fire | - | - | - | - | - | - | - | - | 1 | - | 1 | .20 | - | - | - | - | - | - | - | - | 8 | - | 8 |
| All other | - | 2 | 6 | - | - | 3 | 1 | - | - | - | 12 | 2.45 | - | 2 | 67 | - | - | 18 | 20 | - | - | - | 40 |
| Total or average | 32 | 18 | 172 | 9 | 17 | 85 | 57 | 85 | 12 | 3 | 490 | - | 20 | 6 | 104 | 41 | 35 | 23 | 139 | 39 | 13 | 27 | 68 |
| Percentage distribution | 6.53 | 3.67 | 35.10 | 1.84 | 3.47 | 17.35 | 11.63 | 17.35 | 2.45 | .61 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Surface at underground: | | | | | | | | | | | | | | | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Timber or other support | - | - | - | - | - | - | - | 1 | - | - | 1 | 1.96 | - | - | - | - | - | - | - | 4 | - | - | 4 |
| All other | - | - | - | - | - | - | - | 2 | - | - | 2 | 3.92 | - | - | - | - | - | - | - | 11 | - | - | 11 |

TABLE A-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1955 - Continued

| General work location and detailed cause | Injuries: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | Percentage distribution | Average severity: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Surface at underground - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | - | - | - | 1 | - | - | - | - | 1 | 1.96 | - | - | - | - | - | 6 | - | - | - | - | 6 |
| While operating or moving machinery | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.96 | - | - | 4 | - | - | - | - | - | - | - | 4 |
| All other | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.96 | - | - | 2 | - | - | - | - | - | - | - | 2 |
| From an elevation | - | - | 1 | - | - | - | - | 2 | - | - | 3 | 5.89 | - | - | 5 | - | - | - | - | 138 | - | - | 94 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | - | - | 2 | - | - | 1 | - | 1 | - | 1 | 5 | 9.81 | - | - | 9 | - | - | 19 | - | 9 | - | 12 | 11 |
| Ore, valuable mineral | - | - | - | 1 | - | 1 | - | - | - | 1 | 3 | 5.89 | - | - | - | 52 | - | 3 | - | - | - | 12 | 22 |
| Flying particle while handling material | - | 1 | - | - | - | - | - | - | - | - | 1 | 1.96 | - | 4 | - | - | - | - | - | - | - | - | 4 |
| All other | - | - | 8 | - | - | - | 2 | 5 | - | - | 15 | 29.41 | - | - | 11 | - | - | - | 5 | 13 | - | - | 11 |
| Handtools | 1 | - | - | - | - | - | - | - | - | - | 1 | 1.96 | 3 | - | - | - | - | - | - | - | - | - | 3 |
| Stepping or kneeling on sharp or loose objects: Stepping on loose object | - | - | - | - | - | - | 1 | - | - | - | 1 | 1.96 | - | - | - | - | - | - | 4 | - | - | - | 4 |
| Striking or bumping against objects | - | - | - | - | 1 | - | 1 | - | - | - | 2 | 3.92 | - | - | - | - | 16 | - | 35 | - | - | - | 26 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between | - | - | - | - | - | 1 | - | - | - | - | 1 | 1.96 | - | - | - | - | - | 46 | - | - | - | - | 46 |
| Rerailing | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.96 | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Railroad cars and locomotives | - | - | - | 1 | - | - | - | - | - | - | 1 | 1.96 | - | - | - | 53 | - | - | - | - | - | - | 53 |
| Automobiles, gasoline or diesel trucks | 1 | - | - | - | - | - | - | - | - | - | 1 | 1.96 | 4 | - | - | - | - | - | - | - | - | - | 4 |
| Water transportation | - | - | - | - | - | 1 | - | - | - | - | 1 | 1.96 | - | - | - | - | - | 5 | - | - | - | - | 5 |
| Miscellaneous haulage: Animal on haulage | - | - | - | - | - | - | - | 1 | - | - | 1 | 1.96 | - | - | - | - | - | - | - | 4 | - | - | 4 |
| Electricity: Cable, cable arc, or blowup | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.96 | - | - | 2 | - | - | - | - | - | - | - | 2 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| Belt conveyor | - | - | - | - | - | 1 | - | - | - | - | 1 | 1.96 | - | - | - | - | - | 51 | - | - | - | - | 51 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | - | 1 | - | 1 | - | - | - | 2 | 3.92 | - | - | - | - | 10 | - | 336 | - | - | - | 173 |
| Stationary machinery | - | - | - | - | - | - | - | 1 | - | - | 1 | 1.96 | - | - | - | - | - | - | - | 150 | - | - | 150 |
| While moving any machine except mining or loading | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.96 | - | - | 17 | - | - | - | - | - | - | - | 17 |
| Particle set in motion by machinery | - | 1 | - | - | - | - | - | - | - | - | 1 | 1.96 | - | 1 | - | - | - | - | - | - | - | - | 1 |
| All other | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.96 | - | - | 32 | - | - | - | - | - | - | - | 32 |
| Total or average | 2 | 2 | 17 | 2 | 2 | 6 | 5 | 13 | - | 2 | 51 | - | 4 | 3 | 10 | 53 | 13 | 22 | 77 | 41 | - | 12 | 27 |
| Percentage distribution | 3.92 | 3.92 | 33.33 | 3.92 | 3.92 | 11.77 | 9.81 | 25.49 | - | 3.92 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total or average, underground mines | 34 | 20 | 189 | 11 | 19 | 91 | 62 | 98 | 12 | 5 | 541 | - | 19 | 6 | 96 | 43 | 32 | 23 | 134 | 40 | 13 | 21 | 64 |
| Percentage distribution | 6.29 | 3.70 | 34.94 | 2.03 | 3.51 | 16.82 | 11.46 | 18.11 | 2.22 | .92 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| SURFACE MINING | | | | | | | | | | | | | | | | | | | | | | | |
| Falls of face or side | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 9 | - | - | - | - | - | - | - | 9 |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Timber or other support | 1 | - | - | - | - | - | - | 1 | - | 1 | 3 | .67 | 6 | - | - | - | - | - | - | 10 | - | 17 | 11 |
| Dropped or thrown by coworker | 1 | 1 | - | - | - | - | 3 | - | - | 2 | 7 | 1.56 | 9 | 3 | - | - | - | - | 23 | - | - | 17 | 16 |
| From car, bin, platform, or chute | - | - | - | - | 1 | - | 1 | - | - | - | 2 | .45 | - | - | - | - | 60 | - | 3 | - | - | - | 32 |
| All other | - | 1 | 2 | - | - | - | 1 | 2 | - | - | 6 | 1.34 | - | 5 | 26 | - | - | - | 12 | 5 | - | - | 13 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | 1 | - | 2 | - | - | - | 1 | 3 | - | 2 | 9 | 2.01 | 5 | - | 55 | - | - | - | 5 | 6 | - | 22 | 20 |
| While operating or moving machinery | - | - | 1 | - | - | - | - | - | - | 1 | 2 | .45 | - | - | 24 | - | - | - | - | - | - | 22 | 23 |
| All other | - | - | 9 | 1 | 2 | 1 | 1 | 3 | 1 | - | 18 | 4.02 | - | - | 30 | 42 | 6 | 75 | 12 | 6 | 2 | - | 24 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | - | - | 1 | - | - | - | - | 1 | - | 1 | 3 | .67 | - | - | 30 | - | - | - | - | 49 | - | 22 | 34 |
| While handling material | - | - | 3 | - | - | - | 1 | 1 | - | 3 | 8 | 1.79 | - | - | 9 | - | - | - | 2 | 3 | - | 22 | 12 |
| While operating or moving machinery | - | - | 3 | - | - | - | - | - | 1 | 1 | 5 | 1.12 | - | - | 7 | - | - | - | - | - | 2 | 22 | 9 |
| Caused by failure of scaffold, ladder, or other support | - | - | 3 | - | - | - | 1 | 1 | - | 4 | 9 | 2.01 | - | - | 39 | - | - | - | 16 | 7 | - | 22 | 25 |
| All other | - | - | 6 | - | - | - | 4 | 4 | - | - | 14 | 3.13 | - | - | 40 | - | - | - | 37 | 6 | - | - | 30 |

TABLE A-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause | Injuries | | | | | | | | | | | Percentage distribution | Average severity | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
| SURFACE MINING - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | - | - | 2 | - | 1 | - | - | 2 | - | 4 | 9 | 2.01 | - | - | 7 | - | 37 | - | - | 35 | - | 17 | 21 |
| Ore, valuable mineral | - | - | 1 | - | - | 1 | - | 1 | - | 3 | 6 | 1.34 | - | - | 1 | - | - | 2 | - | 2 | - | 25 | 13 |
| Rail | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 3 | - | - | - | - | - | - | - | 3 |
| Wire or wire rope | - | - | 4 | - | - | 5 | - | - | - | 8 | 17 | 3.79 | - | - | 66 | - | - | 70 | - | - | - | 17 | 44 |
| Flying particle while loading car | - | 2 | - | - | - | - | - | - | - | 2 | 4 | .89 | - | 1 | - | - | - | - | - | - | - | 17 | 9 |
| Flying particle while handling material | - | 7 | - | - | - | - | - | - | - | 7 | 14 | 3.13 | - | 271 | - | - | - | - | - | - | - | 17 | 144 |
| All other | 6 | 1 | 37 | 5 | 2 | 24 | 6 | 11 | - | 7 | 99 | 22.10 | 18 | 2 | 18 | 45 | 2 | 26 | 36 | 22 | - | 18 | 22 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Hammer or sledge | - | - | 1 | - | - | 1 | - | - | - | 1 | 3 | .67 | - | - | 5 | - | - | 20 | - | - | - | 14 | 13 |
| Crowbar or bar | - | - | 1 | - | 1 | 1 | - | 1 | - | 2 | 6 | 1.34 | - | - | 16 | - | 12 | 540 | - | 40 | - | 14 | 106 |
| Handtool used to install rock bolt | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 5 | - | - | - | - | 5 |
| Flying particle from tool or object worked on | 1 | 1 | - | - | - | - | 1 | 1 | - | 1 | 5 | 1.12 | 5 | 9 | - | - | - | - | 22 | 21 | - | 14 | 14 |
| All other | 1 | - | 2 | - | - | 3 | - | - | - | - | 6 | 1.34 | 3 | - | 3 | - | - | 41 | - | - | - | - | 22 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on sharp object | - | - | - | - | - | - | - | 1 | - | - | 1 | .22 | - | - | - | - | - | - | - | 8 | - | - | 8 |
| Stepping on loose object | - | - | - | - | - | 1 | 1 | 1 | - | - | 3 | .67 | - | - | - | - | - | 3 | 7 | 6 | - | - | 5 |
| Striking or bumping against objects | 1 | - | - | - | - | - | - | - | - | - | 1 | .22 | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Skips, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | | | | | | | | | | | | | | | |
| Pulling, pushing, or dropping | - | - | - | - | - | 1 | - | - | - | 1 | 2 | .45 | - | - | - | - | - | 10 | - | - | - | 14 | 12 |
| All other | - | - | - | - | - | - | - | 1 | - | 1 | 2 | .45 | - | - | - | - | - | - | - | 8 | - | 14 | 11 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck or run over | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 75 | - | - | - | - | 75 |
| All other | - | - | - | - | - | - | - | 1 | - | - | 1 | .22 | - | - | - | - | - | - | - | 7 | - | - | 7 |
| Railroad cars and locomotives | 3 | - | 3 | - | 1 | - | 1 | 1 | - | 3 | 12 | 2.68 | 9 | - | 7 | - | 1,000 | - | 4 | 8 | - | 14 | 92 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 6 | - | - | 2 | 1 | 2 | - | 2 | 13 | 2.90 | - | - | 9 | - | - | 26 | 11 | 16 | - | 14 | 14 |
| All other | 2 | - | 3 | - | - | 4 | 1 | 1 | 1 | 4 | 16 | 3.57 | 38 | - | 10 | - | - | 113 | 15 | 65 | 23 | 18 | 46 |
| Water transportation: | | | | | | | | | | | | | | | | | | | | | | | |
| Fall of person | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 5 | - | - | - | - | - | - | - | 5 |
| All other | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 90 | - | - | - | - | - | - | - | 90 |
| Miscellaneous haulage: Rope or cable on haulage | - | - | - | - | - | - | - | 1 | - | 1 | 2 | .45 | - | - | - | - | - | - | - | 41 | - | 14 | 28 |
| Explosives: | | | | | | | | | | | | | | | | | | | | | | | |
| Premature shot or blast | - | 1 | - | - | 1 | - | - | - | - | - | 2 | .45 | - | 1,800 | - | - | 68 | - | - | - | - | - | 934 |
| Cap or detonator | - | 1 | - | - | - | - | - | - | - | - | 1 | .22 | - | 1,620 | - | - | - | - | - | - | - | - | 1,620 |
| Electricity: Cut-out switch or junction box | - | 1 | - | - | - | - | - | - | - | - | 1 | .22 | - | 2 | - | - | - | - | - | - | - | - | 2 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| Belt conveyor | - | - | 1 | - | 2 | - | - | - | - | 2 | 5 | 1.12 | - | - | 4 | - | 10 | - | - | - | - | 32 | 18 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | - | - | - | - | 1 | - | - | 2 | .45 | - | - | 10 | - | - | - | - | 16 | - | - | 13 |
| Mucking machine, mechanical loader | 2 | - | 3 | - | - | - | 1 | 1 | - | 3 | 10 | 2.23 | 1 | - | 10 | - | - | - | 3 | 30 | - | 32 | 16 |
| Power drill; rotary or percussive | - | - | 3 | - | - | 4 | 1 | 5 | - | 3 | 16 | 3.57 | - | - | 11 | - | - | 125 | 720 | 15 | - | 32 | 89 |
| Power shovel, dragline, bulldozer, etc. | 2 | - | 10 | - | 4 | 4 | 1 | - | - | 5 | 26 | 5.80 | 25 | - | 27 | - | 40 | 52 | 7 | - | - | 32 | 33 |
| Stationary machinery | 1 | 1 | 3 | - | - | 6 | 1 | 1 | - | 3 | 16 | 3.57 | 48 | 1 | 41 | - | - | 23 | 63 | 100 | - | 32 | 36 |
| While moving any machinery except mining or loading | - | - | 4 | - | - | 1 | - | 1 | - | 2 | 8 | 1.79 | - | - | 24 | - | - | 7 | - | 6 | - | 32 | 21 |
| Particle set in motion by machinery | - | 5 | - | - | - | - | - | - | - | 2 | 7 | 1.56 | - | 3 | - | - | - | - | - | - | - | 32 | 11 |
| All other | - | - | - | - | - | 3 | - | 1 | - | - | 4 | .89 | - | - | - | - | - | 45 | - | 7 | - | - | 35 |
| Mine fires or suffocation from fires: Oil, gasoline, flammable liquid | - | 1 | - | - | - | - | - | - | - | - | 1 | .22 | - | 63 | - | - | - | - | - | - | - | - | 63 |
| Miscellaneous causes: | | | | | | | | | | | | | | | | | | | | | | | |
| Flying particle from draft or wind | - | 3 | - | - | - | - | - | - | - | - | 3 | .67 | - | 6 | - | - | - | - | - | - | - | - | 6 |
| Acetylene or electric welding or cutting | - | 3 | - | - | - | - | - | 1 | 1 | 2 | 7 | 1.56 | - | 2 | - | - | - | - | - | 15 | 3 | 20 | 9 |
| Irritation or burn from caustic or acid | 1 | 1 | - | - | 1 | - | - | - | - | 1 | 4 | .89 | 20 | 3 | - | - | 60 | - | - | - | - | 20 | 26 |
| Burn from controlled fire | 1 | - | 1 | - | 3 | 1 | 1 | 1 | - | 2 | 10 | 2.23 | 1 | - | 18 | - | 21 | 1 | 11 | 49 | - | 20 | 18 |
| All other | 3 | - | 2 | - | 1 | 2 | - | - | 1 | - | 9 | 2.01 | 28 | - | 74 | - | 9 | 28 | - | - | 28 | - | 36 |

TABLE A-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause | Injuries: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | Percentage distribution | Average severity: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE MINING - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Pneumoconiosis | - | - | 2 | - | - | - | - | - | - | - | 2 | .45 | - | - | 6,000 | - | - | - | - | - | - | - | 6,000 |
| Total or average | 27 | 30 | 124 | 6 | 20 | 67 | 29 | 53 | 5 | 87 | 448 | - | 16 | 182 | 119 | 45 | 75 | 51 | 46 | 19 | 12 | 21 | 67 |
| Percentage distribution | 6.02 | 6.70 | 27.68 | 1.34 | 4.46 | 14.96 | 6.47 | 11.83 | 1.12 | 19.42 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total or average, mining | 61 | 50 | 313 | 17 | 39 | 158 | 91 | 151 | 17 | 92 | 989 | - | 18 | 111 | 105 | 44 | 54 | 35 | 106 | 32 | 12 | 21 | 65 |
| Percentage distribution | 6.16 | 5.06 | 31.65 | 1.72 | 3.94 | 15.98 | 9.20 | 15.27 | 1.72 | 9.30 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MILLS | | | | | | | | | | | | | | | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Timber or other support | - | - | - | - | - | 1 | - | - | - | - | 1 | .07 | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Dropped or thrown by coworker | 1 | 1 | - | - | - | - | 1 | 2 | - | 1 | 6 | .41 | 2 | 1,440 | - | - | - | - | 36 | 30 | - | 13 | 258 |
| From car, bin, platform, or chute | 2 | - | 6 | - | - | 3 | - | 6 | - | 3 | 20 | 1.35 | 2 | - | 13 | - | - | 6 | - | 30 | - | 13 | 16 |
| Falling equipment or machinery under repair | - | - | - | - | - | 1 | 1 | 2 | - | - | 4 | .27 | - | - | - | - | - | 45 | 31 | 12 | - | - | 25 |
| All other | 1 | - | 2 | - | - | 4 | 4 | 10 | 1 | - | 22 | 1.48 | 2 | - | 7 | - | - | 8 | 4 | 9 | 20 | - | 8 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | 25 | 3 | 1 | 2 | 12 | 7 | - | 10 | 60 | 4.05 | - | - | 26 | 39 | 2 | 206 | 24 | 14 | - | 28 | 31 |
| Caused by handtool slipping or breaking | - | - | 1 | - | - | - | - | - | 1 | - | 2 | .13 | - | - | 10 | - | - | - | - | - | 38 | - | 24 |
| While operating or moving machinery | - | - | 2 | - | - | - | - | 1 | - | - | 3 | .20 | - | - | 18 | - | - | - | - | 2 | - | - | 13 |
| All other | 2 | - | 29 | 1 | 4 | 2 | 12 | 14 | 1 | - | 65 | 4.38 | 9 | - | 14 | 45 | 41 | 15 | 16 | 28 | 21 | - | 19 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | - | - | - | - | - | - | - | 1 | - | - | 1 | .07 | - | - | - | - | - | - | - | 20 | - | - | 20 |
| While handling material | 1 | - | 4 | - | 1 | 1 | 2 | 2 | - | 2 | 13 | .88 | 73 | - | 67 | - | 1 | 3 | 16 | 73 | - | 28 | 44 |
| Caused by handtool slipping or breaking | - | - | 1 | - | 1 | - | - | - | - | - | 2 | .13 | - | - | 1 | - | 60 | - | - | - | - | - | 31 |
| Caused by electric current | 1 | - | 1 | - | - | - | - | - | - | - | 2 | .13 | 71 | - | 23 | - | - | - | - | - | - | - | 47 |
| While operating or moving machinery | - | - | 5 | - | - | - | - | 3 | - | 3 | 11 | .74 | - | - | 12 | - | - | - | - | 16 | - | 28 | 18 |
| Caused by failure of scaffold, ladder, or other support | - | - | 5 | - | 2 | - | 2 | 6 | - | - | 15 | 1.01 | - | - | 77 | - | 62 | - | 13 | 129 | - | - | 87 |
| All other | 3 | - | 19 | 4 | 3 | 3 | 10 | 15 | 3 | - | 60 | 4.05 | 19 | - | 23 | 64 | 56 | 37 | 316 | 23 | 26 | - | 77 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | 2 | 1 | 6 | 1 | 2 | 3 | - | 3 | - | 14 | 32 | 2.16 | 2 | 1 | 13 | 37 | 5 | 13 | - | 8 | - | 16 | 13 |
| Ore, valuable mineral | - | - | 8 | 2 | 2 | 1 | 2 | - | - | 8 | 23 | 1.55 | - | - | 16 | 52 | 12 | 19 | 13 | - | - | 16 | 19 |
| Rock or waste | - | - | 1 | - | - | - | - | 2 | - | 3 | 6 | .41 | - | - | 7 | - | - | - | - | 23 | - | 16 | 17 |
| Rail | - | - | 3 | - | - | - | 1 | - | - | 3 | 7 | .47 | - | - | 6 | - | - | - | 22 | - | - | 16 | 12 |
| Wire or wire rope | 1 | 1 | 3 | - | 2 | 4 | 2 | - | - | 8 | 21 | 1.42 | 5 | 1 | 11 | - | 11 | 13 | 2 | - | - | 16 | 12 |
| Flying particle while loading car | - | 3 | - | - | - | - | - | - | - | 2 | 5 | .34 | - | 5 | - | - | - | - | - | - | - | 16 | 9 |
| Flying particle while handling material | - | 22 | 1 | - | - | - | - | - | - | - | 23 | 1.55 | - | 90 | 5 | - | - | - | - | - | - | - | 86 |
| All other | 17 | 5 | 231 | 23 | 27 | 110 | 26 | 75 | 6 | - | 520 | 35.06 | 16 | 3 | 20 | 34 | 17 | 20 | 11 | 27 | 24 | - | 21 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Axe, hatchet, or adz | - | - | 1 | - | - | - | - | - | - | - | 1 | .07 | - | - | 6 | - | - | - | - | - | - | - | 6 |
| Hammer or sledge | - | - | 2 | - | - | 5 | 1 | 2 | - | 2 | 12 | .81 | - | - | 13 | - | - | 5 | 1 | 25 | - | 20 | 12 |
| Crowbar or bar | 1 | - | 3 | - | 2 | 5 | 1 | 2 | - | 2 | 16 | 1.08 | 14 | - | 12 | - | 37 | 21 | 51 | 25 | - | 20 | 23 |
| Shovel | - | - | 1 | - | - | - | - | - | - | - | 1 | .07 | - | - | 3 | - | - | - | - | - | - | - | 3 |
| In hand of fellow worker | 1 | - | - | - | - | - | - | 1 | - | - | 2 | .13 | 45 | - | - | - | - | - | - | 23 | - | - | 34 |
| Flying particle from tool or object worked on | - | 5 | - | - | - | 1 | - | - | - | - | 6 | .41 | - | 379 | - | - | - | 6 | - | - | - | - | 317 |
| All other | 4 | - | 8 | 1 | 1 | 12 | 2 | 1 | - | - | 29 | 1.96 | 9 | - | 45 | 42 | 43 | 33 | 2 | 42 | - | - | 32 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on sharp object | - | - | 1 | - | - | - | - | 9 | - | 1 | 11 | .74 | - | - | 11 | - | - | - | - | 7 | - | 15 | 8 |
| Stepping on loose object | 1 | - | 5 | 1 | 4 | - | 4 | 15 | - | 1 | 31 | 2.09 | 4 | - | 25 | 45 | 33 | - | 20 | 8 | - | 15 | 17 |
| While working on hands and knees | - | - | - | - | - | - | 1 | - | - | - | 1 | .07 | - | - | - | - | - | - | 63 | - | - | - | 63 |
| Striking or bumping against objects | 2 | 2 | 3 | 1 | 3 | - | 2 | 1 | - | - | 14 | .94 | 7 | 9 | 12 | 50 | 6 | - | 3 | 7 | - | - | 10 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | | | | | | | | | | | | | | | |
| Switching, spragging, blocking, or braking | - | - | - | - | - | 1 | - | - | - | - | 1 | .07 | - | - | - | - | - | 54 | - | - | - | - | 54 |
| Pulling, pushing, or dropping | - | - | - | - | - | - | 1 | 1 | - | 1 | 3 | .20 | - | - | - | - | - | - | 98 | 11 | - | 30 | 46 |

TABLE A-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1965 - Continued

| General work location and detailed cause | Injuries | | | | | | | | | | | Percentage distribution | Average severity | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
| MILLS - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Haulage - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| All other | - | - | - | - | - | - | 1 | 1 | - | 1 | 3 | .20 | - | - | - | - | - | - | 6,000 | 267 | - | 30 | 2,099 |
| Squeezed between cage, car or motor, and other object | - | - | - | - | - | - | 1 | - | - | - | 1 | .07 | - | - | - | - | - | - | 10 | - | - | - | 10 |
| Falling, slipping, or jumping into or from | - | - | 1 | - | - | - | - | - | - | - | 1 | .07 | - | - | 71 | - | - | - | - | - | - | - | 71 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck or run over | 1 | - | - | - | - | 1 | 2 | 6 | - | 1 | 11 | .74 | 4 | - | - | - | - | 4 | 49 | 16 | - | 30 | 21 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | - | - | - | - | - | 3 | - | - | 3 | .20 | - | - | - | - | - | - | - | 54 | - | - | 54 |
| All other | - | - | 6 | - | 1 | 4 | - | 2 | 1 | 1 | 15 | 1.01 | - | - | 76 | - | 12 | 26 | - | 4 | 12 | 30 | 41 |
| Railroad cars and locomotives | - | - | 10 | 1 | 1 | 5 | 6 | 9 | 1 | 1 | 34 | 2.29 | - | - | 34 | 97 | 29 | 25 | 25 | 34 | 14 | 30 | 32 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | 2 | - | 2 | - | 2 | 1 | 5 | 4 | 1 | 1 | 18 | 1.21 | 7 | - | 10 | - | 29 | 21 | 31 | 19 | 57 | 30 | 24 |
| All other | - | - | 6 | - | 1 | 2 | 3 | 2 | - | 1 | 15 | 1.01 | - | - | 41 | - | 4 | 39 | 18 | 5 | - | 30 | 28 |
| Water transportation | 1 | - | 1 | - | - | - | - | - | - | - | 2 | .13 | 2 | - | 34 | - | - | - | - | - | - | - | 18 |
| Miscellaneous haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | - | - | - | - | - | 1 | - | - | - | - | 1 | .07 | - | - | - | - | - | 36 | - | - | - | - | 36 |
| Rope or cable on haulage | 2 | - | 1 | - | 1 | 3 | 2 | 3 | 1 | 2 | 15 | 1.01 | 4 | - | 10 | - | 17 | 34 | 1,508 | 618 | 19 | 30 | 339 |
| Animal on haulage | - | - | 1 | - | - | - | - | - | - | - | 1 | .07 | - | - | 3 | - | - | - | - | - | - | - | 3 |
| Slip or strain from moving car by hand | - | - | 4 | - | - | - | 1 | 2 | - | - | 7 | .47 | - | - | 46 | - | - | - | 30 | 3 | - | - | 31 |
| Riding or getting on or off conveyor belt | - | - | - | - | - | - | - | 1 | - | - | 1 | .07 | - | - | - | - | - | - | - | 2 | - | - | 2 |
| Flying particle | - | 6 | - | - | - | - | - | - | - | - | 6 | .41 | - | 4 | - | - | - | - | - | - | - | - | 4 |
| All other | 1 | 1 | 3 | - | - | 1 | - | 3 | 1 | - | 10 | .67 | 5 | 4 | 6 | - | - | 800 | - | 24 | 173 | - | 107 |
| Explosions of gas or dust | - | - | - | - | - | - | - | - | 1 | - | 1 | .07 | - | - | - | - | - | - | - | - | 90 | - | 90 |
| Electricity: | | | | | | | | | | | | | | | | | | | | | | | |
| Transformer, generator, or stationary motor | - | - | - | - | - | - | - | - | 1 | - | 1 | .07 | - | - | - | - | - | - | - | - | 8 | - | 8 |
| Cut-out switch or junction box | 2 | - | - | - | - | 1 | - | - | - | - | 3 | .20 | 29 | - | - | - | - | 5 | - | - | - | - | 21 |
| All other | - | - | - | - | - | - | - | - | 1 | - | 1 | .07 | - | - | - | - | - | - | - | - | 2 | - | 2 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| Belt conveyor | - | - | - | - | 7 | 16 | 2 | 2 | - | 2 | 29 | 1.96 | - | - | - | - | 88 | 76 | 19 | 51 | - | 28 | 70 |
| Chain, bucket, shaker, or screw conveyor | - | - | - | - | - | 5 | 1 | 3 | - | 1 | 10 | .67 | - | - | - | - | - | 271 | 30 | 1,011 | - | 28 | 445 |
| Mucking machine, mechanical loader | - | - | 1 | - | - | - | - | - | - | - | 1 | .07 | - | - | 9 | - | - | - | - | - | - | - | 9 |
| Power shovel, dragline, bulldozer, etc. | 1 | - | 2 | - | - | - | 4 | 2 | - | 1 | 10 | .67 | 12 | - | 31 | - | - | - | 20 | 8 | - | 28 | 20 |
| Stationary machinery | 3 | 1 | 4 | 1 | 3 | 30 | 7 | 8 | - | 3 | 60 | 4.05 | 16 | 2 | 5 | 57 | 1,503 | 229 | 685 | 174 | - | 28 | 296 |
| While moving any machine except mining or loading | - | - | 8 | 1 | - | 5 | 1 | 2 | - | 1 | 18 | 1.21 | - | - | 22 | 26 | - | 47 | 90 | 14 | - | 28 | 33 |
| Particle set in motion by machinery | - | 11 | - | - | 1 | 1 | 1 | - | - | - | 14 | .94 | - | 84 | - | - | 5 | 17 | 17 | - | - | - | 69 |
| All other | - | 2 | 2 | - | - | 4 | - | - | 1 | 1 | 10 | .67 | - | 11 | 37 | - | - | 53 | - | - | 3 | 28 | 34 |
| Suffocation (no flame or smoldering): Foreign gas | - | - | - | - | - | - | - | - | 1 | - | 1 | .07 | - | - | - | - | - | - | - | - | 2 | - | 2 |
| Fires or suffocation from fires: Oil, gasoline, flammable liquid | 1 | 1 | - | - | - | - | - | - | - | - | 2 | .13 | 1 | 1 | - | - | - | - | - | - | - | - | 1 |
| Miscellaneous causes: | | | | | | | | | | | | | | | | | | | | | | | |
| Flying particle from draft or wind | - | 11 | - | - | - | - | - | - | - | 1 | 12 | .81 | - | 4 | - | - | - | - | - | - | - | 17 | 5 |
| Acetylene or electric welding or cutting | - | 13 | - | - | - | 1 | 2 | 2 | - | 1 | 19 | 1.28 | - | 4 | - | - | - | 1 | 12 | 10 | - | 17 | 6 |
| Irritation or burn from caustic or acid | 3 | 9 | 1 | - | 3 | 1 | 3 | 1 | 1 | 2 | 24 | 1.62 | 3 | 36 | 1 | - | 23 | 7 | 2 | 5 | 1 | 17 | 19 |
| Burn from controlled fire | 4 | 1 | 2 | - | 1 | 1 | 6 | 7 | 6 | 2 | 30 | 2.02 | 5 | 10 | 9 | - | 21 | 9 | 28 | 18 | 55 | 17 | 25 |
| All other | 1 | 1 | 19 | - | - | 6 | 6 | 5 | 1 | 1 | 40 | 2.70 | 180 | 11 | 16 | - | - | 23 | 9 | 8 | 2 | 17 | 18 |
| Pneumoconiosis | - | - | 1 | - | - | - | - | - | - | - | 1 | .07 | - | - | 6,000 | - | - | - | - | - | - | - | 6,000 |
| Total or average, mills | 62 | 97 | 452 | 40 | 76 | 248 | 141 | 249 | 30 | 88 | 1,483 | - | 16 | 70 | 35 | 42 | 87 | 60 | 136 | 49 | 34 | 21 | 55 |
| Percentage distribution | 4.18 | 6.54 | 30.48 | 2.70 | 5.13 | 16.72 | 9.51 | 16.79 | 2.02 | 5.93 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Grand total | 123 | 147 | 765 | 57 | 115 | 406 | 232 | 400 | 47 | 180 | 2,472 | - | 17 | 84 | 64 | 42 | 76 | 50 | 125 | 43 | 26 | 21 | 59 |
| Percentage distribution | 4.98 | 5.95 | 30.95 | 2.31 | 4.65 | 16.42 | 9.39 | 16.18 | 1.90 | 7.28 | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE A-5. - Injuries, distribution, average severity by degree, and injury rates at nonmetal mines and mills in the United States, by general work location and part of body injured, 1965

| General work location and part of body injured | Injuries | | | | | | Percentage distribution of all injuries 1/ | Average severity | | | Frequency rates per million man-hours | | Severity rates per million man-hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | | Permanent partial | Temporary total | All injuries | Fatal | Nonfatal | Fatal | Nonfatal |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | |
| **UNDERGROUND MINES** | | | | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | | | | |
| Head, face, neck | 4 | - | - | 32 | 32 | 36 | 7.2 | - | 20 | 684 | 0.38 | 3.04 | 2,279 | 60 |
| Eye | - | - | - | 18 | 18 | 18 | 3.6 | - | 6 | 6 | - | 1.71 | - | 11 |
| Trunk | 2 | 2 | 1 | 169 | 172 | 174 | 34.9 | 1,500 | 26 | 172 | .19 | 16.33 | 1,140 | 1,705 |
| Hernia | - | - | - | 9 | 9 | 9 | 1.8 | - | 41 | 41 | - | .85 | - | 35 |
| Upper extremities | - | - | 1 | 16 | 17 | 17 | 3.4 | 315 | 17 | 35 | - | 1.61 | - | 56 |
| Hand and fingers | - | - | 6 | 79 | 85 | 85 | 17.1 | 149 | 14 | 23 | - | 8.07 | - | 187 |
| Lower extremities | - | - | 4 | 53 | 57 | 57 | 11.5 | 1,575 | 31 | 139 | - | 5.41 | - | 753 |
| Foot and toes | - | - | 3 | 82 | 85 | 85 | 17.1 | 280 | 31 | 39 | - | 8.07 | - | 319 |
| General (multiple) | 5 | - | - | 12 | 12 | 17 | 3.4 | - | 13 | 1,774 | .47 | 1.14 | 2,849 | 15 |
| Not stated | - | - | - | 3 | 3 | 3 | - | - | 27 | 27 | - | .28 | - | 8 |
| Total or average | 11 | 2 | 15 | 473 | 490 | 501 | - | 657 | 24 | 198 | 1.04 | 46.54 | 6,268 | 3,148 |
| Surface: | | | | | | | | | | | | | | |
| Head, face, neck | 1 | - | - | 2 | 2 | 3 | 6.0 | - | 4 | 2,002 | 0.31 | 0.61 | 1,833 | 2 |
| Eye | - | - | - | 2 | 2 | 2 | 4.0 | - | 3 | 3 | - | .61 | - | 2 |
| Trunk | - | - | - | 17 | 17 | 17 | 34.0 | - | 10 | 10 | - | 5.19 | - | 50 |
| Hernia | - | - | - | 2 | 2 | 2 | 4.0 | - | 53 | 53 | - | .61 | - | 32 |
| Upper extremities | - | - | - | 2 | 2 | 2 | 4.0 | - | 13 | 13 | - | .61 | - | 8 |
| Hand and fingers | - | - | - | 6 | 6 | 6 | 12.0 | - | 22 | 22 | - | 1.83 | - | 40 |
| Lower extremities | - | - | - | 5 | 5 | 5 | 10.0 | - | 77 | 77 | - | 1.53 | - | 117 |
| Foot and toes | - | - | 1 | 12 | 13 | 13 | 26.0 | 150 | 32 | 41 | - | 3.97 | - | 162 |
| General (multiple) | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Not stated | - | - | - | 2 | 2 | 2 | - | - | 12 | 12 | - | .61 | - | 7 |
| Total or average | 1 | - | 1 | 50 | 51 | 52 | - | 150 | 25 | 142 | .31 | 15.58 | 1,833 | 420 |
| Total or average, underground mines | 12 | 2 | 16 | 523 | 541 | 553 | - | 625 | 24 | 193 | .87 | 39.20 | 5,216 | 2,501 |
| **OPEN PIT MINES** | | | | | | | | | | | | | | |
| Head, face, neck | 2 | - | - | 24 | 24 | 26 | 8.6 | - | 11 | 471 | 0.11 | 1.30 | 649 | 14 |
| Eye | - | - | 3 | 21 | 24 | 24 | 7.9 | 1,740 | 9 | 226 | - | 1.30 | - | 293 |
| Trunk | - | 2 | - | 106 | 108 | 108 | 35.6 | - | 21 | 131 | - | 5.84 | - | 766 |
| Hernia | - | - | - | 3 | 3 | 3 | 1.0 | - | 54 | 54 | - | .16 | - | 9 |
| Upper extremities | - | - | 1 | 16 | 17 | 17 | 5.6 | 1,000 | 20 | 78 | - | .92 | - | 71 |
| Hand and fingers | - | - | 6 | 49 | 55 | 55 | 18.2 | 251 | 20 | 46 | - | 2.97 | - | 136 |
| Lower extremities | - | - | - | 21 | 21 | 21 | 6.9 | - | 49 | 49 | - | 1.14 | - | 55 |
| Foot and toes | - | - | - | 39 | 39 | 39 | 12.9 | - | 20 | 20 | - | 2.11 | - | 42 |
| General (multiple) | 5 | - | - | 5 | 5 | 10 | 3.3 | - | 12 | 3,006 | .27 | .27 | 1,622 | 3 |
| Not stated | - | - | - | 85 | 85 | 85 | - | - | 21 | 21 | - | 4.60 | - | 96 |
| Total or average | 7 | 2 | 10 | 369 | 381 | 388 | - | 773 | 21 | 179 | .38 | 20.60 | 2,271 | 1,485 |

1/ Number of injuries for which part of body was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 498; for surface, 50; for open pit, 303; for other surface mining, 67; and mills, 1,405.

TABLE A-5. - Injuries, distribution, average severity by degree, and injury rates at nonmetal mines and mills in the United States, by general work location and part of body injured, 1965 - Continued

| General work location and part of body injured | Injuries: Fatal | Nonfatal: Permanent: Total | Nonfatal: Permanent: Partial | Nonfatal: Temporary total | Nonfatal: Total nonfatal | All injuries | Percentage distribution of all injuries 1/ | Average severity: Permanent partial | Average severity: Temporary total | Average severity: All injuries | Frequency rates per million man-hours: Fatal | Frequency rates per million man-hours: Nonfatal | Severity rates per million man-hours: Fatal | Severity rates per million man-hours: Nonfatal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OTHER SURFACE MINING | | | | | | | | | | | | | | |
| Head, face, neck | - | - | - | 3 | 3 | 3 | 4.5 | - | 62 | 62 | - | 0.55 | - | 34 |
| Eye | - | - | - | 6 | 6 | 6 | 9.0 | - | 5 | 5 | - | 1.10 | - | 6 |
| Trunk | - | - | - | 16 | 16 | 16 | 23.8 | - | 40 | 40 | - | 2.93 | - | 117 |
| Hernia | - | - | - | 3 | 3 | 3 | 4.5 | - | 36 | 36 | - | .55 | - | 20 |
| Upper extremities | - | - | - | 3 | 3 | 3 | 4.5 | - | 60 | 60 | - | .55 | - | 33 |
| Hand and fingers | - | - | 3 | 9 | 12 | 12 | 17.9 | 178 | 38 | 73 | - | 2.20 | - | 161 |
| Lower extremities | - | - | - | 8 | 8 | 8 | 11.9 | - | 40 | 40 | - | 1.47 | - | 59 |
| Foot and toes | - | - | - | 14 | 14 | 14 | 20.9 | - | 15 | 15 | - | 2.56 | - | 38 |
| General (multiple) | 2 | - | - | - | - | 2 | 3.0 | - | - | 6,000 | 0.37 | - | 2,198 | - |
| Not stated | - | - | - | 2 | 2 | 2 | - | - | 32 | 32 | - | .37 | - | 12 |
| Total or average | 2 | - | 3 | 64 | 67 | 69 | - | 178 | 33 | 212 | .37 | 12.27 | 2,198 | 479 |
| Total or average, mining | 21 | 4 | 29 | 956 | 989 | 1,010 | - | 630 | 23 | 189 | .56 | 26.19 | 3,337 | 1,711 |
| MILLS | | | | | | | | | | | | | | |
| Head, face, neck | 2 | - | 1 | 61 | 62 | 64 | 4.6 | 140 | 14 | 203 | 0.03 | 0.87 | 169 | 14 |
| Eye | - | - | 4 | 93 | 97 | 97 | 6.9 | 1,485 | 9 | 70 | - | 1.37 | - | 95 |
| Trunk | 3 | 1 | 1 | 450 | 452 | 455 | 32.4 | 70 | 22 | 74 | .04 | 6.37 | 254 | 223 |
| Hernia | - | - | 1 | 39 | 40 | 40 | 2.8 | 50 | 41 | 42 | - | .56 | - | 23 |
| Upper extremities | - | - | 1 | 75 | 76 | 76 | 5.4 | 4,500 | 28 | 87 | - | 1.07 | - | 93 |
| Hand and fingers | - | - | 24 | 224 | 248 | 248 | 17.7 | 454 | 17 | 60 | - | 3.49 | - | 209 |
| Lower extremities | - | 1 | 3 | 137 | 141 | 141 | 10.0 | 3,500 | 20 | 136 | - | 1.99 | - | 271 |
| Foot and toes | - | - | 5 | 244 | 249 | 249 | 17.7 | 1,470 | 20 | 49 | - | 3.51 | - | 172 |
| General (multiple) | 5 | - | - | 30 | 30 | 35 | 2.5 | - | 34 | 886 | .07 | .42 | 423 | 14 |
| Not stated | - | - | - | 88 | 88 | 88 | - | - | 21 | 21 | - | 1.24 | - | 26 |
| Total or average, mills | 10 | 2 | 40 | 1,441 | 1,483 | 1,493 | - | 986 | 21 | 94 | .14 | 20.89 | 845 | 1,141 |
| Grand total or average | 31 | 6 | 69 | 2,397 | 2,472 | 2,503 | - | 836 | 22 | 132 | .29 | 22.73 | 1,711 | 1,339 |

1/ Number of injuries for which part of body was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 498; for surface, 50; for open pit, 303; for other surface mining, 67; and mills, 1,405.

TABLE A-6. - Injuries, distribution, average severity by degree, and injury rates at nonmetal mines and mills in the United States, by general work location and nature of injury, 1965

| General work location and nature of injury | Injuries | | | | | | Percentage distribution of all injuries 1/ | Average severity | | | Frequency rates per million man-hours | | Severity rates per million man-hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | | Permanent partial | Temporary total | All injuries | Fatal | Nonfatal | Fatal | Nonfatal |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | |
| UNDERGROUND MINES | | | | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 9 | - | 9 | 9 | 1.8 | 666 | - | 666 | - | 0.85 | - | 569 |
| Asphxiation and suffocation | 1 | - | - | 7 | 7 | 8 | 1.6 | - | 3 | 753 | 0.09 | .66 | 570 | 2 |
| Bruise or contusion | 3 | - | 2 | 152 | 154 | 157 | 31.5 | 450 | 16 | 136 | .28 | 14.63 | 1,709 | 315 |
| Burn or scald | - | - | - | 8 | 8 | 8 | 1.6 | - | 6 | 6 | - | .76 | - | 4 |
| Chemical burn | - | - | - | 3 | 3 | 3 | .6 | - | 19 | 19 | - | .28 | - | 6 |
| Radiations and radiating substances (includes flash burns of welder's flash) | - | - | - | 4 | 4 | 4 | .8 | - | 14 | 14 | - | .38 | - | 5 |
| Cut, laceration, or puncture | - | - | 1 | 45 | 46 | 46 | 9.3 | 315 | 11 | 18 | - | 4.37 | - | 78 |
| Electric shock | 1 | - | - | 4 | 4 | 5 | 1.0 | - | 11 | 1,208 | .09 | .38 | 570 | 4 |
| Foreign body in eye | - | - | - | 11 | 11 | 11 | 2.2 | - | 6 | 6 | - | 1.04 | - | 6 |
| Fracture | 6 | 1 | 3 | 63 | 67 | 73 | 14.7 | 880 | 59 | 662 | .57 | 6.36 | 3,419 | 1,174 |
| Hernia | - | - | - | 9 | 9 | 9 | 1.8 | - | 41 | 41 | - | .85 | - | 35 |
| Strain, sprain, dislocation | - | - | - | 152 | 152 | 152 | 30.5 | - | 24 | 24 | - | 14.44 | - | 341 |
| Other pneumoconiosis | - | - | - | 1 | 1 | 1 | .2 | - | 4 | 4 | - | .09 | - | - |
| Other, n.e.c. | - | 1 | - | 11 | 12 | 12 | 2.4 | - | 28 | 526 | - | 1.14 | - | 599 |
| Not stated | - | - | - | 3 | 3 | 3 | - | - | 27 | 27 | - | .28 | - | 8 |
| Total or average | 11 | 2 | 15 | 473 | 490 | 501 | - | 657 | 24 | 198 | 1.04 | 46.54 | 6,268 | 3,148 |
| Surface: | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 1 | - | 1 | 1 | 2.0 | 150 | - | 150 | - | 0.31 | - | 46 |
| Bruise or contusion | - | - | - | 14 | 14 | 14 | 28.0 | - | 12 | 12 | - | 4.28 | - | 49 |
| Cut, laceration, or puncture | - | - | - | 4 | 4 | 4 | 8.0 | - | 15 | 15 | - | 1.22 | - | 18 |
| Electric shock | - | - | - | 1 | 1 | 1 | 2.0 | - | 2 | 2 | - | .31 | - | 1 |
| Foreign body in eye | - | - | - | 2 | 2 | 2 | 4.0 | - | 3 | 3 | - | .61 | - | 2 |
| Fracture | 1 | - | - | 7 | 7 | 8 | 16.0 | - | 103 | 840 | 0.31 | 2.14 | 1,833 | 220 |
| Hernia | - | - | - | 2 | 2 | 2 | 4.0 | - | 53 | 53 | - | .61 | - | 32 |
| Strain, sprain, dislocation | - | - | - | 18 | 18 | 18 | 36.0 | - | 8 | 8 | - | 5.50 | - | 46 |
| Not stated | - | - | - | 2 | 2 | 2 | - | - | 12 | 12 | - | .61 | - | 7 |
| Total or average | 1 | - | 1 | 50 | 51 | 52 | - | 150 | 25 | 142 | .31 | 15.58 | 1,833 | 420 |
| Total or average, underground mines | 12 | 2 | 16 | 523 | 541 | 553 | - | 625 | 24 | 193 | .87 | 39.20 | 5,216 | 2,501 |
| OPEN PIT MINES | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 5 | - | 5 | 5 | 1.7 | 626 | - | 626 | - | 0.27 | - | 169 |
| Asphyxiation and suffocation | 1 | - | - | - | - | 1 | .3 | - | - | 6,000 | 0.05 | - | 324 | - |
| Bruise or contusion | 3 | - | 2 | 93 | 95 | 98 | 32.5 | 538 | 20 | 214 | .16 | 5.14 | 973 | 161 |
| Burn or scald (except chemical) | - | - | - | 9 | 9 | 9 | 3.0 | - | 14 | 14 | - | .49 | - | 7 |
| Chemical burn | - | - | - | 1 | 1 | 1 | .3 | - | 1 | 1 | - | .05 | - | - |
| Radiations and radiating substances (includes flash burns of welder's flash) | - | - | - | 1 | 1 | 1 | .3 | - | 1 | 1 | - | .05 | - | - |
| Cut, laceration, or puncture | - | - | - | 26 | 26 | 26 | 8.6 | - | 13 | 13 | - | 1.41 | - | 18 |
| Foreign body in eye | - | - | 2 | 14 | 16 | 16 | 5.3 | 1,710 | 13 | 225 | - | .86 | - | 194 |
| Fracture | 3 | - | 1 | 35 | 36 | 39 | 12.9 | 100 | 41 | 501 | .16 | 1.95 | 973 | 82 |
| Hernia | - | - | - | 3 | 3 | 3 | 1.0 | - | 54 | 54 | - | .16 | - | 9 |
| Poisoning (systemic) | - | - | - | 1 | 1 | 1 | .3 | - | 28 | 28 | - | .05 | - | 2 |
| Strain, sprain, dislocation | - | - | - | 95 | 95 | 95 | 31.5 | - | 18 | 18 | - | 5.14 | - | 92 |
| Silicosis | - | 1 | - | - | 1 | 1 | .3 | - | - | 6,000 | - | .05 | - | 324 |
| Other pneumoconiosis | - | 1 | - | - | 1 | 1 | .3 | - | - | 6,000 | - | .05 | - | 324 |
| Other, n.e.c. | - | - | - | 5 | 5 | 5 | 1.7 | - | 18 | 18 | - | .27 | - | 5 |

1/ Number of injuries for which nature of injury was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 498; for surface, 50; for open pit, 302; for other surface mining, 67; and for mills, 1,398.

TABLE A-6. - Injuries, distribution, average severity by degree, and injury rates at nonmetal mines and mills in the United States, by general work location and nature of injury, 1965 - Continued

| General work location and nature of injury | Injuries: Fatal | Nonfatal: Permanent: Total | Nonfatal: Permanent: Partial | Nonfatal: Temporary total | Nonfatal: Total nonfatal | All injuries | Percentage distribution of all injuries 1/ | Average severity: Permanent partial | Average severity: Temporary total | Average severity: All injuries | Frequency rates per million man-hours: Fatal | Frequency rates per million man-hours: Nonfatal | Severity rates per million man-hours: Fatal | Severity rates per million man-hours: Nonfatal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPEN PIT MINES - Continued | | | | | | | | | | | | | | |
| Not stated | - | - | - | 86 | 86 | 86 | - | - | 21 | 21 | - | 4.65 | - | 98 |
| Total or average | 7 | 2 | 10 | 369 | 381 | 388 | - | 773 | 21 | 179 | .38 | 20.60 | 2,271 | 1,485 |
| OTHER SURFACE MINING | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 3 | - | 3 | 3 | 4.5 | 178 | - | 178 | - | 0.55 | - | 98 |
| Bruise or contusion | - | - | - | 11 | 11 | 11 | 16.4 | - | 40 | 40 | - | 2.01 | - | 80 |
| Burn or scald (except chemical) | - | - | - | 4 | 4 | 4 | 6.0 | - | 15 | 15 | - | .73 | - | 11 |
| Chemical burn | - | - | - | 1 | 1 | 1 | 1.5 | - | 60 | 60 | - | .18 | - | 11 |
| Radiations and radiating substances (includes flash burns of welder's flash) | - | - | - | 1 | 1 | 1 | 1.5 | - | 4 | 4 | - | .18 | - | 1 |
| Cut, laceration, or puncture | - | - | - | 7 | 7 | 7 | 10.4 | - | 18 | 18 | - | 1.28 | - | 24 |
| Drowning | 2 | - | - | - | - | 2 | 3.0 | - | - | 6,000 | 0.37 | - | 2,198 | - |
| Foreign body in eye | - | - | - | 3 | 3 | 3 | 4.5 | - | 7 | 7 | - | .55 | - | 4 |
| Fracture | - | - | - | 11 | 11 | 11 | 16.4 | - | 59 | 59 | - | 2.01 | - | 119 |
| Hernia | - | - | - | 3 | 3 | 3 | 4.5 | - | 36 | 36 | - | .55 | - | 20 |
| Strain, sprain, dislocation | - | - | - | 21 | 21 | 21 | 31.3 | - | 26 | 26 | - | 3.85 | - | 101 |
| Not stated | - | - | - | 2 | 2 | 2 | - | - | 32 | 32 | - | .37 | - | 12 |
| Total or average | 2 | - | 3 | 64 | 67 | 69 | - | 178 | 33 | 212 | .37 | 12.27 | 2,198 | 479 |
| Total or average, mining | 21 | 4 | 29 | 956 | 989 | 1,010 | - | 630 | 23 | 189 | .56 | 26.19 | 3,337 | 1,711 |
| MILLS | | | | | | | | | | | | | | |
| Amputation and enucleation | - | 1 | 29 | - | 30 | 30 | 2.1 | 1,008 | - | 1,175 | - | 0.42 | - | 497 |
| Asphyxiation and suffocation | 1 | - | - | 1 | 1 | 2 | .1 | - | 2 | 3,001 | 0.01 | .01 | 85 | (2/) |
| Bruise or contusion | 2 | - | 2 | 337 | 339 | 341 | 24.4 | 945 | 13 | 54 | .03 | 4.78 | 169 | 88 |
| Burn or scald (except chemical) | - | - | - | 44 | 44 | 44 | 3.1 | - | 21 | 21 | - | .62 | - | 13 |
| Chemical burn | 1 | - | - | 22 | 22 | 23 | 1.6 | - | 19 | 279 | .01 | .31 | 85 | 6 |
| Radiations and radiating substances (includes flash burns or welder's flash) | - | - | - | 11 | 11 | 11 | .8 | - | 4 | 4 | - | .15 | - | 1 |
| Cut, laceration, or puncture | - | - | 1 | 137 | 138 | 138 | 9.9 | 1,800 | 14 | 27 | - | 1.94 | - | 52 |
| Dermatitis | - | - | - | 3 | 3 | 3 | .2 | - | 2 | 2 | - | .04 | - | (2/) |
| Drowning | 1 | - | - | - | - | 1 | .1 | - | - | 6,000 | .01 | - | 85 | - |
| Electric shock | 1 | - | - | 2 | 2 | 3 | .2 | - | 5 | 2,003 | .01 | .03 | 85 | (2/) |
| Foreign body in eye | - | - | 2 | 55 | 57 | 57 | 4.1 | 1,350 | 7 | 54 | - | .80 | - | 44 |
| Fracture | 2 | - | 3 | 169 | 172 | 174 | 12.4 | 1,180 | 48 | 136 | .03 | 2.42 | 169 | 163 |
| Heat exhaustion, sunstroke | - | - | - | 2 | 2 | 2 | .1 | - | 4 | 4 | - | .03 | - | (2/) |
| Hernia | - | - | 1 | 39 | 40 | 40 | 2.9 | 50 | 41 | 42 | - | .56 | - | 23 |
| Poisoning (systemic) | - | - | - | 3 | 3 | 3 | .2 | - | 3 | 3 | - | .04 | - | (2/) |
| Strain, sprain, dislocation | - | - | 1 | 499 | 500 | 500 | 35.8 | 140 | 18 | 18 | - | 7.04 | - | 126 |
| Other pneumoconiosis | - | 1 | - | - | 1 | 1 | .2 | - | - | 6,000 | - | .01 | - | 85 |
| Other, n.e.c. | 1 | - | - | 24 | 24 | 25 | 1.8 | - | 34 | 273 | .01 | .34 | 85 | 11 |
| Not stated | 1 | - | 1 | 93 | 94 | 95 | - | 70 | 24 | 88 | .01 | 1.32 | 85 | 33 |
| Total or average, mills | 10 | 2 | 40 | 1,441 | 1,483 | 1,493 | - | 986 | 21 | 94 | .14 | 20.89 | 845 | 1,141 |
| Grand total or average | 31 | 6 | 69 | 2,397 | 2,472 | 2,503 | - | 836 | 22 | 132 | .29 | 22.73 | 1,711 | 1,339 |

1/ Number of injuries for which nature of injury was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 498; for surface, 50; for open pit, 302; for other surface mining, 67; and for mills, 1,398.
2/ Less than 0.5.

TABLE A-7. - Injury experience and employment data on nonmetal mines and mills in the United States, by general work location and employment size group, 1965

| General work location and employment size group | Injuries | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Active operations | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | | | | | |
| Underground mines (includes surface work): | | | | | | | | | | | | | | |
| 1-4 | 2 | 15 | 17 | 8.48 | 63.61 | 72.09 | 50,885 | 19,535 | 70,420 | 69 | 153 | 194 | 29,728 | 235,828 |
| 5-9 | 1 | 34 | 35 | 1.73 | 58.93 | 60.66 | 10,399 | 2,520 | 12,919 | 42 | 292 | 245 | 71,506 | 577,001 |
| 10-19 | 2 | 33 | 35 | 1.76 | 29.08 | 30.84 | 10,575 | 787 | 11,362 | 39 | 582 | 243 | 141,514 | 1,134,726 |
| 20-49 | - | 58 | 58 | - | 45.65 | 45.65 | - | 959 | 959 | 19 | 575 | 274 | 157,321 | 1,270,398 |
| 50-99 | 3 | 131 | 134 | 1.10 | 48.09 | 49.19 | 6,608 | 1,225 | 7,833 | 18 | 1,190 | 285 | 339,126 | 2,723,884 |
| 100-249 | 4 | 196 | 200 | .91 | 44.50 | 45.41 | 5,450 | 3,770 | 9,219 | 11 | 1,762 | 307 | 540,676 | 4,404,048 |
| 250 or more | - | 74 | 74 | - | 21.41 | 21.41 | - | 1,855 | 1,855 | 4 | 1,274 | 339 | 432,173 | 3,456,661 |
| Total or average | 12 | 541 | 553 | .87 | 39.20 | 40.07 | 5,216 | 2,501 | 7,718 | 202 | 5,828 | 294 | 1,712,044 | 13,802,546 |
| Open pit mines: | | | | | | | | | | | | | | |
| 1-4 | 2 | 63 | 65 | 0.60 | 18.77 | 19.37 | 3,575 | 1,776 | 5,351 | 1,353 | 2,413 | 171 | 412,741 | 3,356,393 |
| 5-9 | 2 | 67 | 69 | .73 | 24.55 | 25.28 | 4,397 | 1,476 | 5,873 | 247 | 1,607 | 210 | 337,405 | 2,729,125 |
| 10-19 | - | 85 | 85 | - | 27.78 | 27.78 | - | 4,483 | 4,483 | 117 | 1,605 | 234 | 375,461 | 3,060,270 |
| 20-49 | 2 | 94 | 96 | .46 | 21.65 | 22.11 | 2,764 | 507 | 3,271 | 63 | 1,952 | 273 | 533,399 | 4,341,600 |
| 50-99 | 1 | 54 | 55 | .29 | 15.69 | 15.98 | 1,743 | 348 | 2,091 | 19 | 1,366 | 311 | 424,252 | 3,442,110 |
| 100-249 | - | 18 | 18 | - | 11.48 | 11.48 | - | 233 | 233 | 5 | 625 | 314 | 196,012 | 1,568,096 |
| 250 or more | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total or average | 7 | 381 | 388 | .38 | 20.60 | 20.98 | 2,271 | 1,485 | 3,756 | 1,804 | 9,568 | 238 | 2,279,270 | 18,497,594 |
| Other surface mining: | | | | | | | | | | | | | | |
| 1-4 | - | 5 | 5 | - | 16.28 | 16.28 | - | 1,000 | 1,000 | 120 | 143 | 267 | 38,167 | 307,144 |
| 5-9 | - | 7 | 7 | - | 25.21 | 25.21 | - | 731 | 731 | 18 | 133 | 257 | 34,152 | 277,679 |
| 10-19 | - | 3 | 3 | - | 9.94 | 9.94 | - | 1,461 | 1,461 | 10 | 125 | 302 | 37,721 | 301,756 |
| 20-49 | - | 3 | 3 | - | 10.51 | 10.51 | - | 46 | 46 | 3 | 118 | 303 | 35,696 | 285,367 |
| 50-99 | 2 | 29 | 31 | 1.02 | 14.79 | 15.81 | 6,119 | 377 | 6,497 | 7 | 527 | 365 | 192,684 | 1,961,020 |
| 100-249 | - | 2 | 2 | - | 3.64 | 3.64 | - | 89 | 89 | 1 | 188 | 365 | 68,620 | 548,960 |
| 250 or more | - | 18 | 18 | - | 10.12 | 10.12 | - | 486 | 486 | 2 | 584 | 365 | 213,292 | 1,778,050 |
| Total or average | 2 | 67 | 69 | .37 | 12.27 | 12.64 | 2,198 | 479 | 2,677 | 161 | 1,818 | 341 | 620,332 | 5,459,976 |
| Total or average, mining | 21 | 989 | 1,010 | .56 | 26.19 | 26.75 | 3,337 | 1,711 | 5,048 | 2,167 | 17,214 | 268 | 4,611,646 | 37,760,116 |
| Mills: | | | | | | | | | | | | | | |
| 1-4 | - | 31 | 31 | - | 40.97 | 40.97 | - | 13,241 | 13,241 | 185 | 430 | 214 | 92,012 | 756,693 |
| 5-9 | 1 | 51 | 52 | 0.57 | 29.04 | 29.61 | 3,417 | 969 | 4,386 | 130 | 884 | 245 | 216,202 | 1,755,936 |
| 10-19 | - | 146 | 146 | - | 33.58 | 33.58 | - | 706 | 706 | 138 | 1,946 | 275 | 534,449 | 4,347,977 |
| 20-49 | 2 | 484 | 486 | .14 | 33.37 | 33.51 | 827 | 1,548 | 2,375 | 215 | 6,691 | 266 | 1,781,515 | 14,502,883 |
| 50-99 | 5 | 372 | 377 | .30 | 22.07 | 22.37 | 1,780 | 857 | 2,637 | 106 | 7,222 | 291 | 2,098,292 | 16,853,716 |
| 100-249 | - | 302 | 302 | - | 15.63 | 15.63 | - | 977 | 977 | 55 | 8,680 | 279 | 2,419,181 | 19,315,662 |
| 250 or more | 2 | 97 | 99 | .15 | 7.22 | 7.36 | 893 | 778 | 1,671 | 16 | 5,362 | 313 | 1,677,181 | 13,442,053 |
| Total or average, mills | 10 | 1,483 | 1,493 | .14 | 20.89 | 21.04 | 845 | 1,141 | 1,987 | 845 | 31,215 | 283 | 8,818,832 | 70,974,920 |
| Grand total or average | 31 | 2,472 | 2,503 | .29 | 22.73 | 23.02 | 1,711 | 1,339 | 3,050 | 3,012 | 48,429 | 277 | 13,430,478 | 108,735,036 |

TABLE A-8. - Injuries by degree at nonmetal mines and mills in the United States, by State 1/, 1965

| State | Injuries: At mines: Fatal | At mines: Nonfatal: Permanent: Total | At mines: Nonfatal: Permanent: Partial | At mines: Nonfatal: Temporary total | At mines: Nonfatal: Total nonfatal | At mines: All injuries | At mills: Fatal | At mills: Nonfatal: Permanent: Total | At mills: Nonfatal: Permanent: Partial | At mills: Nonfatal: Temporary total | At mills: Nonfatal: Total nonfatal | At mills: All injuries |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama---------------- | - | 1 | - | 3 | 4 | 4 | - | - | - | 21 | 21 | 21 |
| Arizona---------------- | - | - | - | 15 | 15 | 15 | 1 | - | - | 4 | 4 | 5 |
| Arkansas--------------- | - | - | - | 17 | 17 | 17 | - | - | 1 | 29 | 30 | 30 |
| California------------- | 1 | - | 1 | 45 | 46 | 47 | - | - | 6 | 112 | 118 | 118 |
| Colorado--------------- | 1 | - | 1 | 10 | 11 | 12 | - | - | - | 10 | 10 | 10 |
| Connecticut------------ | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| District of Columbia---- | - | - | - | 4 | 4 | 4 | - | - | - | 11 | 11 | 11 |
| Florida---------------- | - | - | - | 30 | 30 | 30 | 4 | - | 2 | 28 | 30 | 34 |
| Georgia---------------- | - | - | - | 46 | 46 | 46 | 2 | 1 | - | 126 | 127 | 129 |
| Hawaii----------------- | 1 | - | - | - | - | 1 | - | - | - | - | - | - |
| Idaho------------------ | 1 | - | - | 18 | 18 | 19 | - | - | 1 | 9 | 10 | 10 |
| Illinois--------------- | - | - | 2 | 24 | 26 | 26 | 1 | - | 2 | 55 | 57 | 58 |
| Indiana---------------- | - | - | - | - | - | - | - | - | 1 | 31 | 32 | 32 |
| Iowa------------------- | - | - | 1 | 2 | 3 | 3 | - | - | 1 | 24 | 25 | 25 |
| Kansas----------------- | 1 | - | - | 9 | 9 | 10 | - | - | 2 | 38 | 40 | 40 |
| Kentucky--------------- | - | - | 1 | 37 | 38 | 38 | - | - | - | 8 | 8 | 8 |
| Louisiana-------------- | 2 | 1 | - | 34 | 35 | 37 | - | - | 3 | 61 | 64 | 64 |
| Maine------------------ | 1 | - | - | 1 | 1 | 2 | - | - | - | 3 | 3 | 3 |
| Maryland--------------- | - | - | - | 1 | 1 | 1 | - | - | 1 | 21 | 22 | 22 |
| Massachusetts---------- | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - |
| Michigan--------------- | - | - | - | 6 | 6 | 6 | - | - | 1 | 24 | 25 | 25 |
| Minnesota-------------- | - | - | - | - | - | - | 1 | - | - | 33 | 33 | 34 |
| Mississippi------------ | - | - | - | 3 | 3 | 3 | - | - | 2 | 41 | 43 | 43 |
| Missouri--------------- | - | - | - | 19 | 19 | 19 | - | - | - | 44 | 44 | 44 |
| Montana---------------- | 2 | - | 1 | 24 | 25 | 27 | - | - | - | 6 | 6 | 6 |
| Nevada----------------- | - | - | 1 | 11 | 12 | 12 | - | - | 2 | 33 | 35 | 35 |
| New Hampshire---------- | - | - | - | 2 | 2 | 2 | - | - | - | - | - | - |
| New Jersey------------- | - | - | - | 10 | 10 | 10 | - | - | 1 | 16 | 17 | 17 |
| New Mexico------------- | - | - | 10 | 173 | 183 | 183 | - | - | 3 | 69 | 72 | 72 |
| New York--------------- | - | - | 2 | 57 | 59 | 59 | - | - | 3 | 77 | 80 | 80 |
| North Carolina--------- | 3 | - | - | 15 | 15 | 18 | - | - | 3 | 73 | 76 | 76 |
| North Dakota----------- | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| Ohio------------------- | 2 | - | 2 | 45 | 47 | 49 | - | - | 1 | 77 | 78 | 78 |
| Oklahoma--------------- | 1 | - | 1 | 3 | 4 | 5 | - | - | - | 9 | 9 | 9 |
| Oregon----------------- | - | - | - | 13 | 13 | 13 | - | - | - | 6 | 6 | 6 |
| Pennsylvania----------- | 1 | - | - | 19 | 19 | 20 | 1 | - | 1 | 115 | 116 | 117 |
| South Carolina--------- | - | 1 | - | 11 | 12 | 12 | - | - | - | 23 | 23 | 23 |
| South Dakota----------- | - | - | - | 3 | 3 | 3 | - | - | - | 7 | 7 | 7 |
| Tennessee-------------- | - | - | 1 | 27 | 28 | 28 | - | - | 1 | 17 | 18 | 18 |
| Texas------------------ | - | - | 4 | 81 | 85 | 85 | - | - | - | 70 | 70 | 70 |
| Utah------------------- | 3 | 1 | - | 92 | 93 | 96 | - | - | - | 18 | 18 | 18 |
| Vermont---------------- | - | - | - | 10 | 10 | 10 | - | 1 | - | 11 | 12 | 12 |
| Virginia--------------- | - | - | - | 5 | 5 | 5 | - | - | 1 | 41 | 42 | 42 |
| Washington------------- | - | - | - | 2 | 2 | 2 | - | - | - | - | - | - |
| West Virginia---------- | - | - | 1 | 4 | 5 | 5 | - | - | - | 12 | 12 | 12 |
| Wyoming---------------- | 1 | - | - | 24 | 24 | 25 | - | - | 1 | 25 | 26 | 26 |
| Total-------------- | 21 | 4 | 29 | 956 | 989 | 1,010 | 10 | 2 | 40 | 1,441 | 1,483 | 1,493 |

1/ No injuries were reported at nonmetal mines and mills for States not listed.

TABLE A-9. - Fatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1965

| State | Underground | | | | | | | Shaft and slope | | Total, underground, plus total, shaft and slope | Surface | | Total, underground mines | Open pit | | | | Other surface mining | | | Total, mining activities | Mills | | | | | | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Falls of roof or back | Falls of face or side | Sliding or falling material or objects | Haulage | Electricity | Machinery | Total, underground | Slips or falls of persons | Total, shaft and slope | | Machinery | Total, surface | | Sliding or falling material or objects | Haulage | Machinery | Total, open pit | Slips or falls of persons | Haulage | Total, other surface | | Slips or falls of persons | Handling material | Haulage | Electricity | Miscellaneous causes | Total, mills | |
| Arizona--------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 1 |
| California------ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Colorado-------- | - | 1 | - | - | - | - | 1 | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Florida--------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 | - | 1 | 4 | 4 |
| Georgia--------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | 2 | 2 |
| Hawaii---------- | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Idaho----------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Illinois-------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 1 |
| Kansas---------- | - | - | 1 | - | - | - | 1 | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Louisiana------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 | 2 | - | - | - | - | - | - | 2 |
| Maine----------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Minnesota------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 1 |
| Montana--------- | 1 | - | - | - | - | - | 1 | 1 | 1 | 2 | - | - | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | 2 |
| North Carolina-- | 1 | - | - | - | 1 | - | 2 | - | - | 2 | - | - | 2 | - | - | 1 | 1 | - | - | - | 3 | - | - | - | - | - | - | 3 |
| Ohio------------ | - | - | 1 | - | - | - | 1 | - | - | 1 | 1 | 1 | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | 2 |
| Oklahoma-------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Pennsylvania---- | 1 | - | - | - | - | - | 1 | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 1 | 2 |
| Utah------------ | 1 | - | - | 1 | - | - | 2 | - | - | 2 | - | - | 2 | - | 1 | - | 1 | - | - | - | 3 | - | - | - | - | - | - | 3 |
| Wyoming--------- | - | - | - | - | - | 1 | 1 | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Total------ | 4 | 1 | 2 | 1 | 1 | 1 | 10 | 1 | 1 | 11 | 1 | 1 | 12 | 1 | 2 | 4 | 7 | 1 | 1 | 2 | 21 | 2 | 2 | 4 | 1 | 1 | 10 | 31 |

1/ No fatal injuries were reported at nonmetal mines and mills for States not listed.

TABLE A-10. - Nonfatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1965

| State | Underground mines | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground | | | | | | | | | | | | | | | Shaft and slope | | | | | Total, underground, plus total, shaft and slope |
| | Falls of roof or back | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosives | Electricity | Machinery | Suffocation (no flame or smoldering) | Mine fires or suffocation from fires | Miscellaneous causes | Total, underground | Sliding or falling material or objects | Slips or falls of persons | Striking or bumping against objects | Miscellaneous causes | Total, shaft and slope | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Arizona | 2 | - | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 6 | - | - | - | - | - | 6 |
| Arkansas | - | 1 | 4 | - | 5 | - | 1 | 1 | 1 | - | - | 3 | - | - | 1 | 17 | - | - | - | - | - | 17 |
| California | 1 | - | - | 2 | 3 | 2 | - | - | 1 | - | - | 4 | - | - | - | 13 | - | - | - | - | - | 13 |
| Colorado | - | - | - | 1 | 2 | 1 | 1 | - | 1 | - | - | 2 | - | - | - | 8 | - | - | - | - | - | 8 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| District of Columbia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Georgia | - | - | 1 | - | - | - | - | - | - | - | - | 1 | - | - | - | 2 | 1 | - | - | - | 1 | 3 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Illinois | 6 | 2 | - | 4 | 2 | 1 | - | - | 1 | - | - | 3 | - | - | - | 19 | - | - | - | - | - | 19 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | - | 2 | - | - | - | - | - | - | 1 | 2 | - | - | - | 5 | - | - | - | - | - | 5 |
| Kentucky | 6 | - | 1 | 2 | 3 | 3 | - | - | 10 | 1 | - | 1 | - | - | - | 27 | - | - | - | - | - | 27 |
| Louisiana | - | - | - | - | 3 | 1 | - | - | 3 | 2 | - | 1 | - | - | - | 10 | 1 | - | - | - | 1 | 11 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Michigan | 1 | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | 3 | - | - | - | - | - | 3 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Montana | 2 | - | - | 2 | 3 | 2 | - | - | 3 | - | - | 5 | - | - | - | 17 | - | 1 | - | - | 1 | 18 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | 1 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Mexico | 5 | 3 | 10 | 14 | 39 | 14 | 7 | 3 | 40 | - | 11 | 12 | 1 | 6 | 5 | 170 | - | - | - | - | - | 170 |
| New York | 4 | 2 | 4 | 3 | 11 | - | 2 | 1 | 4 | - | 1 | 5 | - | - | 5 | 42 | - | - | - | - | - | 42 |
| North Carolina | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ohio | - | 5 | 3 | 7 | 7 | 2 | 1 | - | 4 | - | 1 | 3 | - | - | 1 | 34 | - | - | - | - | - | 34 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pennsylvania | - | - | 3 | 1 | 4 | - | - | - | 2 | - | - | 1 | - | - | - | 11 | - | - | - | - | - | 11 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 2 | - | - | - | - | - | 2 |
| Utah | 11 | 5 | 3 | 9 | 17 | 5 | - | - | 7 | - | - | 15 | - | - | 1 | 73 | 5 | - | 1 | - | 6 | 79 |
| Vermont | - | - | - | 2 | 2 | 1 | - | - | - | 2 | - | 1 | - | - | - | 8 | - | - | - | - | - | 8 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | 1 | - | - | - | - | - | - | 2 | - | - | - | 3 | - | - | - | - | - | 3 |
| Wyoming | - | - | - | 1 | 1 | - | - | - | 1 | - | 1 | 1 | - | - | 2 | 7 | 1 | - | - | 1 | 2 | 9 |
| Total | 38 | 18 | 31 | 52 | 105 | 32 | 12 | 5 | 79 | 5 | 15 | 65 | 1 | 6 | 15 | 479 | 8 | 1 | 1 | 1 | 11 | 490 |

1/ No nonfatal injuries were reported at nonmetal mines and mills for the States not listed.

TABLE A-10. - Nonfatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1965 - Continued

| State | Underground mines - continued: Surface: Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Electricity | Machinery | Total, surface | Total, underground mines |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | - | - | - | - |
| Arizona | - | - | - | - | - | - | - | - | - | - | 6 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | 17 |
| California | - | - | 1 | - | - | - | - | - | - | 1 | 14 |
| Colorado | - | - | 1 | - | - | - | - | - | - | 1 | 9 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - |
| District of Columbia | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - |
| Georgia | - | - | - | - | - | - | - | - | 1 | 1 | 4 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - |
| Illinois | - | 1 | - | - | - | - | - | - | 1 | 2 | 21 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - |
| Iowa | - | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | 2 | - | - | - | - | - | - | 2 | 7 |
| Kentucky | - | - | 1 | - | - | - | - | - | - | 1 | 28 |
| Louisiana | - | 1 | 1 | - | - | - | 1 | - | - | 3 | 14 |
| Maine | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - | - |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - | - | - | 3 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - |
| Missouri | - | - | - | - | - | - | - | - | - | - | - |
| Montana | - | - | - | - | - | - | - | - | - | - | 18 |
| Nevada | - | - | - | - | - | - | - | - | - | - | 1 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - |
| New Mexico | 2 | 2 | 6 | - | - | 2 | 1 | - | - | 13 | 183 |
| New York | - | 1 | 3 | 1 | 1 | - | - | - | 1 | 7 | 49 |
| North Carolina | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - |
| Ohio | - | - | 2 | - | - | - | 2 | - | - | 4 | 38 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - |
| Oregon | - | - | - | - | - | - | - | - | - | - | - |
| Pennsylvania | - | - | - | - | - | - | - | - | - | - | 11 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - |
| Texas | - | - | 2 | - | - | - | - | - | - | 2 | 4 |
| Utah | 1 | 1 | 5 | - | - | - | 2 | 1 | 1 | 11 | 90 |
| Vermont | - | - | - | - | - | - | - | - | 1 | 1 | 9 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - |
| Washington | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | - | - | 3 |
| Wyoming | - | - | - | - | - | - | - | - | 1 | 1 | 10 |
| Total | 3 | 6 | 24 | 1 | 1 | 2 | 6 | 1 | 7 | 51 | 541 |

| State | Open pit mines: Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosives | Electricity | Machinery | Mine fires or suffocation from fires | Miscellaneous causes | Pneumoconiosis | Total, open pit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | 1 | - | - | 1 | - | 1 | 1 | 4 |
| Arizona | - | 1 | 1 | 3 | - | 1 | - | 1 | - | - | 2 | - | - | - | 9 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| California | - | 3 | - | 9 | - | - | - | 4 | - | - | 10 | - | - | - | 26 |
| Colorado | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | 2 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| District of Columbia | - | 1 | 1 | 1 | - | - | - | - | - | - | 1 | - | - | - | 4 |
| Florida | - | - | 2 | 11 | 2 | - | - | 3 | - | - | 8 | - | 2 | - | 28 |
| Georgia | - | 1 | 20 | 10 | 1 | - | - | 2 | - | - | 7 | - | 1 | - | 42 |
| Idaho | - | - | 1 | 3 | 1 | - | - | 5 | - | - | 6 | - | 2 | - | 18 |
| Illinois | - | - | 1 | 1 | - | - | - | 1 | - | - | 2 | - | - | - | 5 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Iowa | - | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - | 3 |
| Kansas | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | 2 |
| Kentucky | - | - | 1 | 7 | - | - | - | 1 | - | - | 1 | - | - | - | 10 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Maine | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| Maryland | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| Massachusetts | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| Michigan | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | 1 | - | - | 1 | - | 1 | - | 3 |
| Missouri | - | 2 | 2 | 6 | - | 1 | - | 3 | - | - | 4 | - | 1 | - | 19 |
| Montana | - | - | 1 | 4 | 1 | - | - | - | - | - | 1 | - | - | - | 7 |
| Nevada | - | - | 1 | 2 | - | - | - | 2 | - | - | 2 | 1 | 3 | - | 11 |
| New Hampshire | - | - | - | - | 1 | - | - | 1 | - | - | - | - | - | - | 2 |
| New Jersey | - | - | - | 4 | 2 | - | 1 | - | - | - | 2 | - | - | - | 9 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New York | - | - | - | 6 | - | - | - | 1 | 2 | - | - | - | - | - | 9 |
| North Carolina | - | 2 | 1 | 2 | 1 | - | - | 3 | - | 1 | - | - | 3 | - | 13 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ohio | - | 1 | 1 | 4 | 1 | - | - | - | - | - | 1 | - | 1 | - | 9 |
| Oklahoma | - | - | 1 | 1 | - | - | - | 1 | - | - | - | - | - | - | 3 |
| Oregon | - | - | - | 4 | - | - | - | 1 | - | - | 5 | - | 3 | - | 13 |
| Pennsylvania | - | - | 2 | 4 | - | - | - | 1 | - | - | - | - | 1 | - | 8 |
| South Carolina | - | - | 2 | 4 | 1 | - | - | 1 | - | - | 3 | - | - | 1 | 12 |
| South Dakota | - | - | - | - | - | 1 | - | 1 | - | - | 1 | - | - | - | 3 |
| Tennessee | - | 1 | 3 | 7 | 1 | - | - | 1 | - | - | 12 | - | 3 | - | 28 |
| Texas | - | 4 | 5 | 19 | 3 | - | - | 4 | 1 | - | 10 | - | 2 | - | 48 |
| Utah | 1 | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | 3 |
| Vermont | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Virginia | - | - | - | 2 | 1 | - | - | 2 | - | - | - | - | - | - | 5 |
| Washington | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 |
| West Virginia | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Wyoming | - | 1 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | - | 1 | - | 14 |
| Total | 1 | 17 | 53 | 124 | 19 | 3 | 1 | 46 | 3 | 1 | 85 | 1 | 25 | 2 | 381 |

1/ No nonfatal injuries were reported at nonmetal mines and mills for the States not listed.

TABLE A-10. - Nonfatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1965 - Continued

| State | Other surface mining | | | | | | | | | Total, mining activities | Mills | | | | | | | | | | | | | | | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Haulage | Machinery | Miscellaneous causes | Total, other surface mining | | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosions of gas or dust | Electricity | Machinery | Suffocation (no flames or smoldering) | Fires or suffocation from fires | Miscellaneous causes | Pneumoconiosis | Total, mills | |
| Alabama | - | - | - | - | - | - | - | - | - | 4 | 2 | 6 | 7 | - | - | - | 1 | - | - | 2 | - | - | 3 | - | 21 | 25 |
| Arizona | - | - | - | - | - | - | - | - | - | 15 | - | 1 | 3 | - | - | - | - | - | - | - | - | - | - | - | 4 | 19 |
| Arkansas | - | - | - | - | - | - | - | - | - | 17 | 2 | 3 | 16 | 3 | - | - | - | - | 1 | 3 | - | - | 2 | - | 30 | 47 |
| California | - | - | 1 | - | - | 4 | - | 1 | 6 | 46 | 5 | 13 | 46 | 10 | 3 | 2 | 15 | - | - | 13 | - | - | 11 | - | 118 | 164 |
| Colorado | - | - | - | - | - | - | - | - | - | 11 | - | - | 5 | 1 | 1 | - | 1 | - | - | 1 | - | - | 1 | - | 10 | 21 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | 2 | 2 |
| District of Columbia | - | - | - | - | - | - | - | - | - | 4 | 2 | - | 7 | - | - | - | - | - | - | - | - | - | 2 | - | 11 | 15 |
| Florida | - | 1 | 1 | - | - | - | - | - | 2 | 30 | - | 8 | 9 | 2 | - | 2 | 1 | - | - | 3 | - | - | 5 | - | 30 | 60 |
| Georgia | - | - | - | - | - | - | - | - | - | 46 | 9 | 16 | 65 | 6 | 3 | 2 | 8 | 1 | - | 9 | - | - | 8 | - | 127 | 173 |
| Idaho | - | - | - | - | - | - | - | - | - | 18 | - | 3 | 2 | 1 | - | - | 1 | - | - | 1 | - | - | 2 | - | 10 | 28 |
| Illinois | - | - | - | - | - | - | - | - | - | 26 | 2 | 11 | 24 | 3 | 1 | - | 10 | - | - | 4 | - | - | 2 | - | 57 | 83 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | 19 | - | - | - | 3 | - | - | 8 | - | - | 2 | - | 32 | 32 |
| Iowa | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 16 | 3 | 1 | - | 2 | - | - | - | - | - | - | - | 25 | 28 |
| Kansas | - | - | - | - | - | - | - | - | - | 9 | 2 | 7 | 24 | 1 | - | - | - | - | - | 3 | - | - | 3 | - | 40 | 49 |
| Kentucky | - | - | - | - | - | - | - | - | - | 38 | - | - | 7 | - | - | - | - | - | - | - | - | 1 | - | - | 8 | 46 |
| Louisiana | - | 4 | 4 | 1 | - | 1 | 6 | 4 | 20 | 35 | - | 10 | 21 | 3 | 2 | 2 | 8 | - | 3 | 5 | 1 | - | 9 | - | 64 | 99 |
| Maine | - | - | - | - | - | - | - | - | - | 1 | - | 2 | - | - | - | - | 1 | - | - | - | - | - | - | - | 3 | 4 |
| Maryland | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 9 | 2 | 3 | - | 1 | - | - | 4 | - | - | 1 | - | 22 | 23 |
| Massachusetts | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Michigan | - | 1 | 1 | - | - | - | - | - | 2 | 6 | - | 7 | 14 | - | - | - | 2 | - | - | 2 | - | - | - | - | 25 | 31 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | 3 | 1 | 20 | - | 1 | - | 2 | - | - | 2 | - | - | 4 | - | 33 | 33 |
| Mississippi | - | - | - | - | - | - | - | - | - | 3 | 1 | 7 | 19 | 3 | - | - | 3 | - | - | 8 | - | - | 2 | - | 43 | 46 |
| Missouri | - | - | - | - | - | - | - | - | - | 19 | 2 | 7 | 12 | 2 | 3 | - | 13 | - | - | 1 | - | - | 4 | - | 44 | 63 |
| Montana | - | - | - | - | - | - | - | - | - | 25 | - | 2 | 3 | - | - | - | - | - | - | - | - | - | 1 | - | 6 | 31 |
| Nevada | - | - | - | - | - | - | - | - | - | 12 | 1 | 6 | 10 | 3 | 3 | - | 4 | - | - | 2 | - | - | 6 | - | 35 | 47 |
| New Hampshire | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| New Jersey | - | - | 1 | - | - | - | - | - | 1 | 10 | 1 | 4 | 4 | - | - | - | 1 | - | - | 4 | - | - | 3 | - | 17 | 27 |
| New Mexico | - | - | - | - | - | - | - | - | - | 183 | 2 | 11 | 17 | 2 | 3 | 4 | 12 | - | 1 | 12 | - | - | 8 | - | 72 | 255 |
| New York | - | - | 1 | - | - | - | - | - | 1 | 59 | 6 | 18 | 28 | 3 | 4 | - | 8 | - | - | 6 | - | - | 7 | - | 80 | 139 |
| North Carolina | - | - | - | - | - | - | - | - | - | 15 | 4 | 9 | 38 | 5 | 3 | - | 5 | - | - | 7 | - | - | 5 | - | 76 | 91 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 |
| Ohio | - | - | - | - | - | - | - | - | - | 47 | 2 | 17 | 30 | 2 | 5 | - | 15 | - | - | 3 | - | 1 | 3 | - | 78 | 125 |
| Oklahoma | - | - | 1 | - | - | - | - | - | 1 | 4 | - | 1 | 6 | - | 1 | - | 1 | - | - | - | - | - | - | - | 9 | 13 |
| Oregon | - | - | - | - | - | - | - | - | - | 13 | - | 1 | 1 | 1 | 1 | - | 2 | - | - | - | - | - | - | - | 6 | 19 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | 19 | 3 | 14 | 65 | 2 | 2 | 1 | 8 | - | - | 12 | - | - | 9 | - | 116 | 135 |
| South Carolina | - | - | - | - | - | - | - | - | - | 12 | 1 | 2 | 10 | - | - | - | 4 | - | - | 4 | - | - | 2 | - | 23 | 35 |
| South Dakota | - | - | - | - | - | - | - | - | - | 3 | 1 | 2 | 3 | - | - | - | - | - | - | 1 | - | - | - | - | 7 | 10 |
| Tennessee | - | - | - | - | - | - | - | - | - | 28 | - | 5 | 2 | - | 1 | - | 2 | - | - | 7 | - | - | 1 | - | 18 | 46 |
| Texas | 1 | 9 | 16 | 1 | 1 | - | 2 | 3 | 33 | 85 | - | 7 | 29 | 5 | 1 | - | 8 | - | - | 10 | - | - | 10 | - | 70 | 155 |
| Utah | - | - | - | - | - | - | - | - | - | 93 | - | 2 | 12 | 1 | - | - | - | - | - | 1 | - | - | 2 | - | 18 | 111 |
| Vermont | - | - | - | - | - | - | - | - | - | 10 | - | 2 | 3 | - | - | - | 2 | - | - | 3 | - | - | 1 | 1 | 12 | 22 |
| Virginia | - | - | - | - | - | - | - | - | - | 5 | - | 12 | 20 | 1 | 1 | 1 | 1 | - | - | 3 | - | - | 3 | - | 42 | 47 |
| Washington | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| West Virginia | - | - | - | - | - | - | 1 | - | 1 | 5 | - | 5 | 5 | 1 | - | - | - | - | - | 1 | - | - | - | - | 12 | 17 |
| Wyoming | - | - | - | - | - | - | - | - | - | 24 | 1 | 8 | 6 | 1 | - | - | 2 | - | - | 7 | - | - | 1 | - | 26 | 50 |
| Total | 1 | 15 | 26 | 2 | 1 | 5 | 9 | 8 | 67 | 989 | 53 | 234 | 637 | 67 | 43 | 14 | 148 | 1 | 5 | 152 | 1 | 2 | 125 | 1 | 1,483 | 2,472 |

1/ No nonfatal injuries were reported at nonmetal mines and mills for the States not listed.

TABLE A-11. - Injuries by general work location and main cause at nonmetal mines and mills in the United States, by degree of injury and mineral industry, 1965

| Degree of injury and mineral industry | Underground mines | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground | | | | | | | | | | | | | | | | Shaft and slope | | | | | Total, underground, plus total, shaft and slope |
| | Falls of roof or back | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosives | Electricity | Machinery | Suffocation (no flame or smoldering) | Mine fires or suffocation from fires | Miscellaneous causes | Total, underground | Sliding or falling material or objects | Slips or falls of persons | Striking or bumping against objects | Miscellaneous causes | Total, shaft and slope | |
| **Fatal and nonfatal:** | | | | | | | | | | | | | | | | | | | | | | |
| Clay | 3 | 7 | 6 | 8 | 20 | 2 | - | - | 7 | - | - | 9 | - | - | - | 62 | - | - | - | - | - | 62 |
| Gypsum | 1 | - | - | 1 | 2 | 1 | - | - | 1 | - | - | 1 | - | - | - | 7 | - | 1 | - | - | 1 | 8 |
| Phosphate rock | 12 | 3 | 2 | 7 | 7 | 4 | - | - | 6 | - | - | 11 | - | - | 1 | 53 | 5 | 1 | 1 | - | 7 | 60 |
| Potash | 6 | 3 | 10 | 14 | 40 | 15 | 7 | 3 | 41 | - | 11 | 15 | 1 | 6 | 5 | 177 | - | - | - | - | - | 177 |
| Salt | 3 | 2 | 4 | 7 | 17 | 3 | 3 | 1 | 10 | 2 | 3 | 11 | - | - | 5 | 71 | 1 | - | - | - | 1 | 72 |
| Sulfur | - | - | - | - | 1 | - | 1 | - | 1 | - | - | 1 | - | - | - | 4 | - | - | - | - | - | 4 |
| Miscellaneous nonmetals 1/ | 17 | 4 | 11 | 15 | 18 | 7 | 1 | 1 | 14 | 3 | 2 | 18 | - | - | 4 | 115 | 2 | - | - | 1 | 3 | 118 |
| Total | 42 | 19 | 33 | 52 | 105 | 32 | 12 | 5 | 80 | 5 | 16 | 66 | 1 | 6 | 15 | 489 | 8 | 2 | 1 | 1 | 12 | 501 |
| **Fatal:** | | | | | | | | | | | | | | | | | | | | | | |
| Clay | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | 3 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 1 |
| Phosphate rock | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Potash | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Salt | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | 2 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | 1 | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 3 | - | - | - | - | - | 3 |
| Total | 4 | 1 | 2 | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | 10 | - | 1 | - | - | 1 | 11 |
| **Permanent total:** | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Salt | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | 1 | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 2 | - | - | - | - | - | 2 |
| **Permanent partial:** | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Gypsum | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | 2 | - | - | - | 6 | - | - | 2 | - | - | - | 10 | - | - | - | - | - | 10 |
| Salt | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | 3 | - | - | - | - | - | 3 |
| Total | 1 | - | - | - | 4 | 1 | - | - | 6 | - | - | 3 | - | - | - | 15 | - | - | - | - | - | 15 |
| **Temporary total:** | | | | | | | | | | | | | | | | | | | | | | |
| Clay | 1 | 6 | 6 | 8 | 19 | 2 | - | - | 7 | - | - | 9 | - | - | - | 58 | - | - | - | - | - | 58 |
| Gypsum | 1 | - | - | 1 | 1 | 1 | - | - | 1 | - | - | 1 | - | - | - | 6 | - | - | - | - | - | 6 |
| Phosphate rock | 11 | 3 | 2 | 7 | 7 | 4 | - | - | 6 | - | - | 11 | - | - | 1 | 52 | 5 | 1 | 1 | - | 7 | 59 |
| Potash | 5 | 3 | 10 | 14 | 38 | 15 | 7 | 3 | 34 | - | 11 | 13 | 1 | 6 | 5 | 165 | - | - | - | - | - | 165 |
| Salt | 3 | 2 | 2 | 7 | 17 | 3 | 3 | 1 | 10 | 1 | 3 | 11 | - | - | 5 | 68 | 1 | - | - | - | 1 | 69 |
| Sulfur | - | - | - | - | 1 | - | 1 | - | 1 | - | - | 1 | - | - | - | 4 | - | - | - | - | - | 4 |
| Miscellaneous nonmetals 1/ | 15 | 4 | 11 | 15 | 18 | 6 | 1 | 1 | 14 | 3 | 1 | 16 | - | - | 4 | 109 | 2 | - | - | 1 | 3 | 112 |
| Total | 36 | 18 | 31 | 52 | 101 | 31 | 12 | 5 | 73 | 4 | 15 | 62 | 1 | 6 | 15 | 462 | 8 | 1 | 1 | 1 | 11 | 473 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE A-11. - Injuries by general work location and main cause at nonmetal mines and mills in the United States, by degree of injury and mineral industry, 1965 - Continued

| Degree of injury and mineral industry | Underground mines - continued | | | | | | | | | | | Open pit mines | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Electricity | Machinery | Total, surface | Total, underground mines | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosives | Electricity | Machinery | Mine fires or suffocation from fires | Miscellaneous causes | Pneumoconiosis | Total, open pit |
| Fatal and nonfatal: | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | 1 | 5 | - | - | - | 4 | - | 1 | 11 | 73 | 1 | 13 | 41 | 84 | 13 | 1 | 1 | 18 | - | 1 | 37 | - | 11 | 1 | 222 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 8 | - | 1 | 3 | 2 | - | - | - | 3 | - | - | 4 | - | - | - | 13 |
| Phosphate rock | 1 | - | - | - | - | - | - | - | - | 1 | 61 | - | - | 4 | 15 | 3 | - | - | 10 | - | - | 24 | - | 5 | - | 61 |
| Potash | 2 | 2 | 8 | - | - | 2 | 1 | 1 | - | 16 | 193 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | 2 | 8 | 1 | 1 | - | 1 | - | 2 | 15 | 87 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | 1 | 3 | - | - | - | - | - | 5 | 9 | 127 | - | 4 | 5 | 23 | 3 | 2 | - | 17 | 3 | - | 24 | - | 9 | 1 | 91 |
| Total | 3 | 6 | 24 | 1 | 1 | 2 | 6 | 1 | 8 | 52 | 553 | 1 | 18 | 53 | 124 | 19 | 3 | 1 | 48 | 3 | 1 | 89 | 1 | 25 | 2 | 388 |
| Fatal: | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Potash | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | 1 | 1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - | - | - | - | - | - | - | 3 | - | - | - | 4 |
| Total | - | - | - | - | - | - | - | - | 1 | 1 | 12 | - | 1 | - | - | - | - | - | 2 | - | - | 4 | - | - | - | 7 |
| Permanent total: | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Total | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Permanent partial: | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 2 | 1 | - | - | 1 | - | - | 1 | - | - | - | 5 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - | - | 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | 1 | 1 | 4 | - | - | - | 2 | - | - | - | - | 2 | - | - | - | - | - | 4 |
| Total | - | - | - | - | - | - | - | - | 1 | 1 | 16 | - | - | - | 4 | 1 | - | - | 2 | 2 | - | 1 | - | - | - | 10 |
| Temporary total: | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | 1 | 5 | - | - | - | 4 | - | 1 | 11 | 69 | 1 | 13 | 41 | 82 | 12 | 1 | 1 | 16 | - | 1 | 36 | - | 11 | - | 215 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 6 | - | 1 | 3 | 2 | - | - | - | 2 | - | - | 3 | - | - | - | 11 |
| Phosphate rock | 1 | - | - | - | - | - | - | - | - | 1 | 60 | - | - | 4 | 15 | 3 | - | - | 9 | - | - | 24 | - | 5 | - | 60 |
| Potash | 2 | 2 | 8 | - | - | 2 | 1 | 1 | - | 16 | 181 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | 2 | 8 | 1 | 1 | - | 1 | - | 1 | 14 | 83 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | 1 | 3 | - | - | - | - | - | 4 | 8 | 120 | - | 3 | 5 | 21 | 3 | 2 | - | 17 | 1 | - | 21 | - | 9 | - | 82 |
| Total | 3 | 6 | 24 | 1 | 1 | 2 | 6 | 1 | 6 | 50 | 523 | 1 | 17 | 53 | 120 | 18 | 3 | 1 | 44 | 1 | 1 | 84 | 1 | 25 | - | 369 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE A-11. - Injuries by general work location and main cause at nonmetal mines and mills in the United States, by degree of injury and mineral industry, 1965 - Continued

| Degree of injury and mineral industry | Other surface mining | | | | | | | | | | Mills | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Haulage | Machinery | Miscellaneous causes | Total, other surface mining | Total, mining activities | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosions of gas or dust | Electricity | Machinery | Suffocation (no flame or smoldering) | Fires or suffocation from fires | Miscellaneous causes | Pneumoconiosis | Total, mills | Grand total |
| **Fatal and nonfatal:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 295 | 38 | 127 | 445 | 39 | 23 | 3 | 77 | 1 | 2 | 90 | - | 2 | 48 | - | 895 | 1,190 |
| Gypsum | - | - | - | - | - | - | - | - | - | 21 | 1 | 5 | 6 | 2 | 2 | - | 2 | - | - | 6 | - | - | 1 | - | 25 | 46 |
| Phosphate rock | - | 1 | 1 | - | - | - | - | - | 2 | 124 | - | 12 | 15 | 4 | 1 | 1 | 5 | - | - | 8 | - | - | 12 | - | 58 | 182 |
| Potash | - | - | - | - | - | - | - | - | - | 193 | 2 | 11 | 17 | 3 | 3 | 4 | 11 | - | 1 | 10 | - | - | 10 | - | 72 | 265 |
| Salt | - | 1 | 5 | - | - | 4 | 1 | 1 | 12 | 100 | 2 | 34 | 68 | 1 | 4 | 2 | 16 | - | 3 | 10 | - | - | 14 | - | 154 | 254 |
| Sulfur | 1 | 13 | 19 | 2 | 1 | 2 | 8 | 7 | 53 | 57 | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 59 |
| Miscellaneous nonmetals 1/ | - | 1 | 1 | - | - | - | - | - | 2 | 220 | 10 | 47 | 87 | 17 | 10 | 4 | 41 | - | - | 28 | 1 | - | 41 | 1 | 287 | 507 |
| Total | 1 | 16 | 26 | 2 | 1 | 6 | 9 | 8 | 69 | 1,010 | 53 | 236 | 639 | 67 | 43 | 14 | 152 | 1 | 6 | 152 | 1 | 2 | 126 | 1 | 1,493 | 2,503 |
| **Fatal:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 4 | - | 2 | - | - | - | - | 2 | - | 1 | - | - | - | - | - | 5 | 9 |
| Gypsum | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | 2 | - | - | 1 | - | - | - | 2 | - | - | - | - | - | 1 | - | 4 | 6 |
| Potash | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Salt | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| Sulfur | - | 1 | - | - | - | 1 | - | - | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | 7 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 8 |
| Total | - | 1 | - | - | - | 1 | - | - | 2 | 21 | - | 2 | 2 | - | - | - | 4 | - | 1 | - | - | - | 1 | - | 10 | 31 |
| **Permanent total:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | 2 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Salt | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| Total | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 2 | 6 |
| **Permanent partial:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 6 | - | 1 | 3 | 1 | - | - | - | - | - | 6 | - | - | - | - | 11 | 17 |
| Gypsum | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 1 | - | - | - | - | - | 3 | - | - | - | - | 4 | 6 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | 3 | - | - | - | - | 5 | 5 |
| Potash | - | - | - | - | - | - | - | - | - | 10 | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 11 |
| Salt | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | 2 | - | - | - | 1 | - | - | 4 | - | - | - | - | 7 | 8 |
| Sulfur | - | 1 | - | 1 | - | - | - | - | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | 8 | 1 | 3 | - | - | - | - | 2 | - | - | 6 | - | - | - | - | 12 | 20 |
| Total | - | 1 | - | 1 | - | - | 1 | - | 3 | 29 | 1 | 4 | 6 | 2 | - | - | 4 | - | - | 23 | - | - | - | - | 40 | 69 |
| **Temporary total:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 284 | 38 | 124 | 442 | 38 | 23 | 3 | 74 | 1 | 1 | 84 | - | 2 | 48 | - | 878 | 1,162 |
| Gypsum | - | - | - | - | - | - | - | - | - | 17 | 1 | 5 | 6 | 1 | 2 | - | 2 | - | - | 3 | - | - | 1 | - | 21 | 38 |
| Phosphate rock | - | 1 | 1 | - | - | - | - | - | 2 | 122 | - | 12 | 13 | 4 | 1 | 1 | 2 | - | - | 5 | - | - | 11 | - | 49 | 171 |
| Potash | - | - | - | - | - | - | - | - | - | 181 | 2 | 11 | 17 | 3 | 3 | 4 | 11 | - | 1 | 9 | - | - | 10 | - | 71 | 252 |
| Salt | - | 1 | 5 | - | - | 4 | - | 1 | 11 | 95 | 2 | 34 | 66 | 1 | 4 | 2 | 15 | - | 3 | 6 | - | - | 14 | - | 147 | 242 |
| Sulfur | 1 | 11 | 19 | 1 | 1 | 1 | 8 | 7 | 49 | 53 | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 55 |
| Miscellaneous nonmetals 1/ | - | 1 | 1 | - | - | - | - | - | 2 | 204 | 9 | 44 | 86 | 17 | 10 | 4 | 39 | - | - | 22 | 1 | - | 41 | - | 273 | 477 |
| Total | 1 | 14 | 26 | 1 | 1 | 5 | 8 | 8 | 64 | 956 | 52 | 230 | 631 | 65 | 43 | 14 | 143 | 1 | 5 | 129 | 1 | 2 | 125 | - | 1,441 | 2,397 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE A-12. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by mineral industry, 1965

| Mineral industry | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| Clay | 3 | - | 3 | 1 | - | 4 | 5 | 9 | 59 | 11 | 70 | 221 | - | 291 | 890 | 1,181 |
| Gypsum | 1 | - | 1 | 1 | - | 2 | - | 2 | 7 | - | 7 | 12 | - | 19 | 25 | 44 |
| Phosphate rock | 1 | - | 1 | 1 | - | 2 | 4 | 6 | 59 | 1 | 60 | 60 | 2 | 122 | 54 | 176 |
| Potash | 1 | - | 1 | - | - | 1 | - | 1 | 176 | 16 | 192 | - | - | 192 | 72 | 264 |
| Salt | 2 | 1 | 3 | - | - | 3 | - | 3 | 70 | 14 | 84 | 1 | 12 | 97 | 154 | 251 |
| Sulfur | - | - | - | - | 2 | 2 | - | 2 | 4 | - | 4 | - | 51 | 55 | 2 | 57 |
| Miscellaneous nonmetals 1/ | 3 | - | 3 | 4 | - | 7 | 1 | 8 | 115 | 9 | 124 | 87 | 2 | 213 | 286 | 499 |
| Total | 11 | 1 | 12 | 7 | 2 | 21 | 10 | 31 | 490 | 51 | 541 | 381 | 67 | 989 | 1,483 | 2,472 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Clay | 4.12 | - | 3.48 | 0.11 | - | 0.40 | 0.17 | 0.23 | 80.94 | 82.44 | 81.17 | 24.65 | - | 29.46 | 29.55 | 29.53 |
| Gypsum | 1.46 | - | 1.19 | .86 | - | 1.00 | - | .23 | 10.22 | - | 8.30 | 10.36 | - | 9.49 | 3.81 | 5.14 |
| Phosphate rock | .86 | - | .73 | .22 | - | .34 | .65 | .49 | 50.49 | 5.06 | 43.92 | 13.15 | 62.81 | 20.46 | 8.71 | 14.47 |
| Potash | .28 | - | .20 | - | - | .20 | - | .12 | 50.11 | 11.04 | 38.70 | - | - | 38.37 | 22.40 | 32.12 |
| Salt | .99 | 1.22 | 1.05 | - | - | .80 | - | .24 | 34.53 | 17.04 | 29.48 | 13.62 | 14.60 | 25.90 | 17.17 | 19.75 |
| Sulfur | - | - | - | - | 0.46 | .45 | - | .45 | 35.64 | - | 28.76 | - | 11.79 | 12.32 | 81.97 | 12.69 |
| Miscellaneous nonmetals 1/ | 1.31 | - | 1.08 | 1.07 | - | 1.04 | .06 | .35 | 50.10 | 18.53 | 44.58 | 23.28 | 10.64 | 31.76 | 17.99 | 22.08 |
| Combined rate | 1.04 | .31 | .87 | .38 | .37 | .56 | .14 | .29 | 46.54 | 15.58 | 39.20 | 20.60 | 12.27 | 26.19 | 20.89 | 22.73 |
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Clay | 24,694 | - | 20,873 | 669 | - | 2,430 | 996 | 1,350 | 2,172 | 1,379 | 2,049 | 1,570 | - | 1,604 | 1,051 | 1,187 |
| Gypsum | 8,764 | - | 7,115 | 5,181 | - | 5,996 | - | 1,402 | 232 | - | 189 | 627 | - | 442 | 588 | 554 |
| Phosphate rock | 5,134 | - | 4,392 | 1,315 | - | 2,013 | 3,872 | 2,960 | 1,038 | 20 | 891 | 316 | 283 | 447 | 1,321 | 893 |
| Potash | 1,708 | - | 1,209 | - | - | 1,199 | - | 730 | 4,355 | 270 | 3,162 | - | - | 3,135 | 1,959 | 2,675 |
| Salt | 5,919 | 7,303 | 6,318 | - | - | 4,807 | - | 1,416 | 3,698 | 232 | 2,699 | 858 | 1,033 | 2,297 | 867 | 1,288 |
| Sulfur | - | - | - | - | 2,774 | 2,687 | - | 2,673 | 285 | - | 230 | - | 392 | 387 | 82 | 385 |
| Miscellaneous nonmetals 1/ | 7,842 | - | 6,472 | 6,423 | - | 6,263 | 377 | 2,124 | 3,209 | 1,247 | 2,866 | 2,989 | 346 | 2,864 | 1,463 | 1,878 |
| Combined rate | 6,268 | 1,833 | 5,216 | 2,271 | 2,198 | 3,337 | 845 | 1,711 | 3,148 | 420 | 2,501 | 1,485 | 479 | 1,711 | 1,141 | 1,339 |

| Mineral industry | Active operations | | | | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | | | | Underground | Surface | Total | | | | | | | | | | |
| Clay | 47 | 1,235 | 8 | 1,290 | 470 | 411 | 76 | 487 | 5,021 | 36 | 5,544 | 14,136 | 19,680 | 222 | 220 | 170 | 220 | 264 |
| Gypsum | 18 | 56 | - | 74 | 50 | 345 | 79 | 424 | 546 | - | 970 | 2,890 | 3,860 | 248 | 260 | - | 255 | 283 |
| Phosphate rock | 8 | 49 | 9 | 66 | 40 | 544 | 90 | 634 | 1,853 | 20 | 2,507 | 2,476 | 4,983 | 270 | 304 | 195 | 294 | 312 |
| Potash | 11 | - | 1 | 12 | 11 | 1,233 | 504 | 1,737 | - | 16 | 1,753 | 1,126 | 2,879 | 357 | - | 332 | 357 | 357 |
| Salt | 16 | 9 | 82 | 107 | 48 | 880 | 368 | 1,248 | 40 | 350 | 1,638 | 3,909 | 5,547 | 277 | 230 | 293 | 279 | 284 |
| Sulfur | 1 | 2 | 11 | 14 | 1 | 46 | 11 | 57 | 2 | 1,312 | 1,371 | 10 | 1,381 | 305 | 38 | 365 | 362 | 305 |
| Miscellaneous nonmetals 1/ | 101 | 453 | 50 | 604 | 225 | 1,034 | 207 | 1,241 | 2,106 | 84 | 3,431 | 6,668 | 10,099 | 278 | 219 | 277 | 242 | 296 |
| Total or average | 202 | 1,804 | 161 | 2,167 | 845 | 4,493 | 1,335 | 5,828 | 9,568 | 1,818 | 17,214 | 31,215 | 48,429 | 294 | 238 | 341 | 268 | 283 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromide, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE A-12. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by mineral industry, 1965 - Continued

| Mineral industry | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Clay------------------------ | 91,208 | 16,848 | 108,056 | 1,102,955 | 6,107 | 1,217,118 | 3,738,329 | 4,955,447 | 728,918 | 133,436 | 862,354 | 8,964,831 | 49,472 | 9,876,657 | 30,116,089 | 39,992,746 |
| Gypsum---------------------- | 85,349 | 19,737 | 105,086 | 141,813 | - | 246,899 | 817,246 | 1,064,145 | 684,656 | 158,660 | 843,316 | 1,157,970 | - | 2,001,286 | 6,556,827 | 8,558,113 |
| Phosphate rock-------------- | 146,106 | 24,785 | 170,891 | 563,279 | 3,905 | 738,075 | 773,372 | 1,511,447 | 1,168,650 | 197,555 | 1,366,205 | 4,564,395 | 31,840 | 5,962,440 | 6,198,328 | 12,160,768 |
| Potash---------------------- | 439,060 | 181,115 | 620,175 | - | 5,313 | 625,488 | 401,767 | 1,027,255 | 3,512,442 | 1,448,958 | 4,961,400 | - | 42,507 | 5,003,907 | 3,214,144 | 8,218,051 |
| Salt------------------------ | 243,902 | 101,176 | 345,078 | 9,205 | 102,408 | 456,691 | 1,109,273 | 1,565,964 | 2,027,352 | 821,585 | 2,848,937 | 73,432 | 822,183 | 3,744,552 | 8,966,871 | 12,711,423 |
| Sulfur---------------------- | 14,030 | 3,355 | 17,385 | 75 | 479,341 | 496,801 | 3,050 | 499,851 | 112,240 | 26,840 | 139,080 | 601 | 4,325,990 | 4,465,671 | 24,400 | 4,490,071 |
| Miscellaneous nonmetals 1/- | 284,725 | 60,648 | 345,373 | 461,943 | 23,258 | 830,574 | 1,975,795 | 2,806,369 | 2,295,444 | 485,810 | 2,781,254 | 3,736,365 | 187,984 | 6,705,603 | 15,898,261 | 22,603,864 |
| Total----------------- | 1,304,380 | 407,664 | 1,712,044 | 2,279,270 | 620,332 | 4,611,646 | 8,818,832 | 13,430,478 | 10,529,702 | 3,272,844 | 13,802,546 | 18,497,594 | 5,459,976 | 37,760,116 | 70,974,920 | 108,735,036 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromide, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE A-13. - Injury experience and employment data by general work location at miscellaneous nonmetal mines and mills in the United States, by mineral industry, 1965

| Mineral industry | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| Asbestos-------------------- | - | - | - | 1 | - | 1 | - | 1 | 6 | - | 6 | 7 | - | 13 | 16 | 29 |
| Barite---------------------- | - | - | - | - | - | - | - | - | 18 | - | 18 | 17 | - | 35 | 83 | 118 |
| Boron minerals-------------- | - | - | - | - | - | - | - | - | 2 | - | 2 | - | - | 2 | 16 | 18 |
| Feldspar-------------------- | - | - | - | 1 | - | 1 | 1 | 2 | - | - | - | 11 | - | 11 | 5 | 16 |
| Fluorspar------------------- | - | - | - | - | - | - | - | - | 46 | 3 | 49 | - | - | 49 | 7 | 56 |
| Magnesite------------------- | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 7 | 46 | 53 |
| Mica------------------------ | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 4 | - | 4 | 10 | 14 |
| Pumice---------------------- | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 11 | - | 11 | 3 | 14 |
| Sodium compounds------------ | 1 | - | 1 | - | - | 1 | - | 1 | 9 | 1 | 10 | - | - | 10 | 19 | 29 |
| Talc, soapstone, and pyrophyllite--------------- | 2 | - | 2 | - | - | 2 | - | 2 | 32 | 4 | 36 | 4 | - | 40 | 25 | 65 |
| Other nonmetals 1/---------- | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 26 | 2 | 31 | 56 | 87 |
| Total----------------- | 3 | - | 3 | 4 | - | 7 | 1 | 8 | 115 | 9 | 124 | 87 | 2 | 213 | 286 | 499 |

1/ Abrasives, bromine, calcium chloride, diatomite, epsomite, graphite, greensand, iodine, kyanite, lithium, mineral pigments, perlite, vermiculite, and wollastonite.

TABLE A-13. - Injury experience and employment data by general work location at miscellaneous nonmetal mines and mills in the United States, by mineral industry, 1965 - Continued

| Mineral industry | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Asbestos------------------ | - | - | - | 3.89 | - | 2.76 | - | 1.01 | 72.00 | - | 56.97 | 27.24 | - | 35.88 | 25.42 | 29.24 |
| Barite-------------------- | - | - | - | - | - | - | - | - | 134.16 | - | 116.88 | 20.15 | - | 35.08 | 50.66 | 44.77 |
| Boron minerals------------ | - | - | - | - | - | - | - | - | 598.80 | - | 355.56 | - | - | 6.31 | 4.95 | 5.07 |
| Feldspar------------------ | - | - | - | 2.30 | - | 2.28 | 2.06 | 2.17 | - | - | - | 25.26 | - | 25.10 | 10.31 | 17.33 |
| Fluorspar----------------- | - | - | - | - | - | - | - | - | 64.16 | 21.06 | 57.02 | - | - | 55.29 | 13.43 | 39.79 |
| Magnesite----------------- | - | - | - | - | - | - | - | - | - | - | - | 30.78 | - | 27.64 | 19.11 | 19.92 |
| Mica---------------------- | - | - | - | 5.57 | - | 5.54 | - | 1.49 | - | - | - | 22.28 | - | 22.18 | 20.28 | 20.79 |
| Pumice-------------------- | - | - | - | 2.31 | - | 2.31 | - | 1.81 | - | - | - | 25.36 | - | 25.36 | 25.52 | 25.39 |
| Sodium compounds---------- | 1.58 | - | 1.22 | - | - | 1.17 | - | .37 | 14.20 | 5.47 | 12.25 | - | - | 11.66 | 10.25 | 10.70 |
| Talc, soapstone, and pyrophyllite------------- | 2.96 | - | 2.54 | - | - | 2.12 | - | 1.00 | 47.42 | 35.63 | 45.74 | 25.80 | - | 42.46 | 23.55 | 32.44 |
| Other nonmetals 1/--------- | - | - | - | - | - | - | - | - | 42.06 | 235.85 | 57.93 | 29.63 | 18.53 | 29.89 | 16.19 | 19.35 |
| Combined rate--------- | 1.31 | - | 1.08 | 1.07 | - | 1.04 | .06 | .35 | 50.10 | 18.53 | 44.58 | 23.28 | 10.64 | 31.76 | 17.99 | 22.08 |
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Asbestos------------------ | - | - | - | 23,349 | - | 16,561 | - | 6,050 | 744 | - | 589 | 381 | - | 442 | 435 | 438 |
| Barite-------------------- | - | - | - | - | - | - | - | - | 2,199 | - | 1,915 | 2,248 | - | 2,196 | 1,224 | 1,592 |
| Boron minerals------------ | - | - | - | - | - | - | - | - | 599 | - | 356 | - | - | 6 | 211 | 192 |
| Feldspar------------------ | - | - | - | 13,776 | - | 13,691 | 12,371 | 12,997 | - | - | - | 278 | - | 276 | 186 | 229 |
| Fluorspar----------------- | - | - | - | - | - | - | - | - | 2,113 | 1,474 | 2,007 | - | - | 1,946 | 420 | 1,381 |
| Magnesite----------------- | - | - | - | - | - | - | - | - | - | - | - | 387 | - | 347 | 2,338 | 2,148 |
| Mica---------------------- | - | - | - | 33,417 | - | 33,268 | - | 8,910 | - | - | - | 33,823 | - | 33,673 | 6,537 | 13,805 |
| Pumice-------------------- | - | - | - | 13,832 | - | 13,831 | - | 10,882 | - | - | - | 712 | - | 712 | 732 | 716 |
| Sodium compounds---------- | 9,466 | - | 7,348 | - | - | 6,994 | - | 2,213 | 297 | 5 | 231 | - | - | 220 | 574 | 462 |
| Talc, soapstone, and pyrophyllite------------- | 17,782 | - | 15,246 | - | - | 12,738 | - | 5,989 | 1,156 | 3,430 | 1,480 | 12,405 | - | 3,278 | 6,326 | 4,893 |
| Other nonmetals 1/--------- | - | - | - | - | - | - | - | - | 95,125 | 2,358 | 87,530 | 751 | 602 | 5,069 | 945 | 1,896 |
| Combined rate--------- | 7,842 | - | 6,472 | 6,423 | - | 6,263 | 377 | 2,124 | 3,209 | 1,247 | 2,866 | 2,989 | 346 | 2,864 | 1,463 | 1,878 |

| Mineral industry | Active operations | | | | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under-ground mines | Open pit mines | Other surface mining | Total mining activities | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | | | | Underground | Surface | Total | | | | | | | | | | |
| Asbestos------------------ | 5 | 8 | - | 13 | 7 | 48 | 13 | 61 | 134 | - | 195 | 289 | 484 | 216 | 239 | - | 232 | 272 |
| Barite-------------------- | 3 | 47 | 1 | 51 | 40 | 69 | 10 | 79 | 406 | 1 | 486 | 740 | 1,226 | 244 | 256 | 10 | 254 | 274 |
| Boron minerals------------ | 2 | 1 | 1 | 4 | 5 | 3 | 1 | 4 | 105 | 6 | 115 | 1,345 | 1,460 | 176 | 356 | 250 | 344 | 300 |
| Feldspar------------------ | 1 | 94 | 1 | 96 | 10 | 1 | - | 1 | 256 | 2 | 259 | 207 | 466 | 80 | 212 | 130 | 211 | 293 |
| Fluorspar----------------- | 27 | 6 | - | 33 | 10 | 346 | 65 | 411 | 25 | - | 436 | 226 | 662 | 261 | 134 | - | 254 | 288 |
| Magnesite----------------- | - | 12 | 22 | 34 | 16 | - | - | - | 132 | 11 | 143 | 987 | 1,130 | - | 204 | 293 | 211 | 303 |
| Mica---------------------- | 1 | 42 | - | 43 | 18 | 1 | - | 1 | 107 | - | 108 | 230 | 338 | 100 | 205 | - | 204 | 268 |
| Pumice-------------------- | - | 117 | 1 | 118 | 26 | - | - | - | 376 | 1 | 377 | 100 | 477 | - | 144 | 3 | 143 | 144 |
| Sodium compounds---------- | 14 | 1 | 4 | 19 | 6 | 235 | 67 | 302 | 1 | 16 | 319 | 637 | 956 | 339 | 156 | 313 | 337 | 364 |
| Talc, soapstone, and pyrophyllite------------- | 39 | 50 | - | 89 | 27 | 307 | 49 | 356 | 118 | - | 474 | 454 | 928 | 269 | 162 | - | 243 | 279 |
| Other nonmetals 1/--------- | 9 | 75 | 20 | 104 | 60 | 24 | 2 | 26 | 446 | 47 | 519 | 1,453 | 1,972 | 250 | 244 | 282 | 247 | 297 |
| Total or average------ | 101 | 453 | 50 | 604 | 225 | 1,034 | 207 | 1,241 | 2,106 | 84 | 3,431 | 6,668 | 10,099 | 278 | 219 | 277 | 242 | 296 |

1/ Abrasives, bromine, calcium chloride, diatomite, epsomite, graphite, greensand, iodine, kyanite, lithium, mineral pigments, perlite, vermiculite, and wollastonite.

TABLE A-13. - Injury experience and employment data by general work location at miscellaneous nonmetal mines and mills in the United States, by mineral industry, 1965 - Continued

| | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Asbestos------------------- | 10,417 | 2,749 | 13,166 | 32,076 | - | 45,242 | 78,676 | 123,918 | 83,333 | 21,992 | 105,325 | 256,971 | - | 362,296 | 629,411 | 991,707 |
| Barite--------------------- | 16,772 | 2,480 | 19,252 | 104,063 | 10 | 123,325 | 202,675 | 326,000 | 134,167 | 19,843 | 154,010 | 843,516 | 80 | 997,606 | 1,638,306 | 2,635,912 |
| Boron minerals------------- | 417 | 286 | 703 | 37,392 | 1,500 | 39,595 | 404,136 | 443,731 | 3,340 | 2,285 | 5,625 | 299,136 | 12,000 | 316,761 | 3,233,247 | 3,550,008 |
| Feldspar------------------- | 80 | - | 80 | 54,214 | 260 | 54,554 | 60,563 | 115,117 | 640 | - | 640 | 435,532 | 2,080 | 438,252 | 485,009 | 923,261 |
| Fluorapar------------------ | 89,519 | 17,805 | 107,324 | 3,353 | - | 110,677 | 65,142 | 175,819 | 716,933 | 142,457 | 859,390 | 26,823 | - | 886,213 | 521,132 | 1,407,345 |
| Magnesite------------------ | - | - | - | 26,905 | 3,227 | 30,132 | 299,008 | 329,140 | - | - | - | 227,433 | 25,822 | 253,255 | 2,406,745 | 2,660,000 |
| Mica----------------------- | 100 | - | 100 | 21,952 | - | 22,052 | 61,631 | 83,683 | 800 | - | 800 | 179,552 | - | 180,352 | 493,045 | 673,397 |
| Pumice--------------------- | - | - | - | 54,070 | 3 | 54,073 | 14,427 | 68,500 | - | - | - | 433,791 | 12 | 433,803 | 117,556 | 551,359 |
| Sodium compounds----------- | 79,233 | 23,113 | 102,346 | 156 | 5,012 | 107,514 | 231,703 | 339,217 | 633,862 | 182,742 | 816,604 | 1,248 | 40,075 | 857,927 | 1,853,617 | 2,711,544 |
| Talc, soapstone, and pyrophyllite-------------- | 82,206 | 13,685 | 95,891 | 19,144 | - | 115,035 | 126,621 | 241,656 | 674,821 | 112,251 | 787,072 | 155,013 | - | 942,085 | 1,061,562 | 2,003,647 |
| Other nonmetals 1/--------- | 5,981 | 530 | 6,511 | 108,618 | 13,246 | 128,375 | 431,213 | 559,588 | 47,548 | 4,240 | 51,788 | 877,350 | 107,915 | 1,037,053 | 3,458,631 | 4,495,684 |
| Total------------------ | 284,725 | 60,648 | 345,373 | 461,943 | 23,258 | 830,574 | 1,975,795 | 2,806,369 | 2,295,444 | 485,810 | 2,781,254 | 3,736,365 | 187,984 | 6,705,603 | 15,898,261 | 22,603,864 |

1/ Abrasives, bromine, calcium chloride, diatomite, epsomite, graphite, greensand, iodine, kyanite, lithium, mineral pigments, perlite, vermiculite, and wollastonite.

TABLE A-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1965

| State | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Injuries | | | | | | | | | | | | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 18 | 20 |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | 5 | - | 5 | - | 5 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 24 | 24 |
| California | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 45 | 47 |
| Colorado | 1 | - | 1 | - | - | 1 | - | 1 | 4 | 1 | 5 | 1 | - | 6 | 5 | 11 |
| Delaware | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 8 | 9 |
| Georgia | - | - | - | - | - | - | 2 | 2 | - | - | - | 36 | - | 36 | 121 | 157 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 5 | 6 |
| Illinois | - | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 5 | - | 6 | 49 | 55 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 27 | 27 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 21 | 24 |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 24 | 26 |
| Kentucky | - | - | - | - | - | - | - | - | - | - | - | 10 | - | 10 | 7 | 17 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 8 | 9 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 3 | 4 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 21 | 22 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 6 |
| Minnesota | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | 33 | 33 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 35 | 38 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 9 | - | 9 | 2 | 11 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | 9 | - | 9 | 11 | 20 |
| New York | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 7 | 30 | 37 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 7 | 52 | 59 |
| Ohio | - | - | - | - | - | - | - | - | 12 | 3 | 15 | 8 | - | 23 | 61 | 84 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 9 | 10 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 9 | - | 9 | 4 | 13 |
| Pennsylvania | 1 | - | 1 | - | - | 1 | 1 | 2 | 11 | - | 11 | 8 | - | 19 | 116 | 135 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 9 | - | 9 | 19 | 28 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 6 | 7 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 14 | - | 14 | 13 | 27 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 40 | - | 40 | 39 | 79 |
| Utah | 1 | - | 1 | 1 | - | 2 | - | 2 | 28 | 7 | 35 | 2 | - | 37 | 1 | 38 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 30 | 34 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | 3 | - | 3 | 1 | - | 4 | 9 | 13 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | 12 | - | 12 | 12 | 24 |
| Other States 1/ | - | - | - | - | - | - | - | - | - | - | - | 6 | - | 6 | 16 | 22 |
| Total | 3 | - | 3 | 1 | - | 4 | 5 | 9 | 59 | 11 | 70 | 221 | - | 291 | 890 | 1,181 |

1/ Includes Connecticut, District of Columbia, Hawaii, Massachusetts, Montana, Nebraska, New Mexico, North Dakota, Vermont, and Wisconsin.

TABLE A-14.- Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1965 - Continued

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | 12.52 | - | 10.40 | 13.41 | 13.03 |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | 115.16 | - | 115.16 | - | 62.33 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 46.08 | 41.01 |
| California | - | - | - | - | - | - | - | - | - | - | - | 5.31 | - | 5.30 | 36.09 | 28.94 |
| Colorado | 28.59 | - | 25.03 | - | - | 7.46 | - | 3.35 | 114.37 | 200.64 | 125.13 | 10.63 | - | 44.77 | 30.43 | 36.87 |
| Delaware | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | 6.42 | - | 5.66 | 20.50 | 15.88 |
| Georgia | - | - | - | - | - | - | 0.37 | .29 | - | - | - | 24.61 | - | 24.61 | 22.14 | 22.66 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 31.49 | - | 31.49 | 56.81 | 50.09 |
| Illinois | - | - | - | - | - | - | .63 | .56 | 69.06 | - | 53.65 | 32.22 | - | 34.52 | 30.64 | 31.02 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 33.19 | 28.14 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 14.37 | - | 14.37 | 27.17 | 24.45 |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | 33.61 | - | 32.28 | 95.18 | 82.77 |
| Kentucky | - | - | - | - | - | - | - | - | - | - | - | 23.67 | - | 23.67 | 36.19 | 27.60 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | 7.78 | - | 7.78 | 25.73 | 20.48 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | 34.41 | - | 24.00 | 25.58 | 25.17 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 8.91 | - | 8.34 | 76.06 | 55.56 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.85 | 12.47 |
| Minnesota | - | - | - | - | - | - | 2.15 | 2.08 | - | - | - | - | - | - | 70.86 | 68.63 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 14.69 | - | 14.69 | 29.23 | 27.11 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 19.68 | - | 19.68 | 7.66 | 15.31 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | 41.68 | - | 41.68 | 28.94 | 33.55 |
| New York | - | - | - | - | - | - | - | - | - | - | - | 29.37 | - | 29.37 | 38.53 | 36.38 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | 19.92 | - | 19.92 | 31.08 | 29.14 |
| Ohio | - | - | - | - | - | - | - | - | 52.66 | 64.69 | 54.70 | 11.96 | - | 24.38 | 23.14 | 23.46 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 5.28 | - | 5.28 | 30.67 | 20.72 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 134.86 | - | 134.54 | 33.67 | 70.00 |
| Pennsylvania | 4.88 | - | 3.82 | - | - | .93 | .45 | .61 | 53.66 | - | 42.04 | 9.93 | - | 17.76 | 52.13 | 40.97 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 27.92 | - | 27.92 | 15.08 | 17.70 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 14.73 | - | 14.73 | 35.77 | 29.71 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 42.07 | - | 42.07 | 22.19 | 29.39 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 69.86 | - | 68.61 | 25.42 | 37.31 |
| Utah | 5.89 | - | 5.80 | 8.38 | - | 6.86 | - | 5.90 | 164.82 | 2,887.79 | 203.12 | 16.77 | - | 126.90 | 21.08 | 112.09 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 27.84 | - | 27.84 | 46.97 | 43.46 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | 70.33 | - | 57.22 | 18.77 | - | 37.84 | 12.26 | 15.48 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | 37.34 | - | 37.34 | 21.74 | 27.48 |
| Other States 1/ | - | - | - | - | - | - | - | - | - | - | - | 45.77 | - | 45.77 | 33.74 | 36.35 |
| Combined rate | 4.12 | - | 3.48 | .11 | - | .40 | .17 | .23 | 80.94 | 82.44 | 81.17 | 24.65 | - | 29.46 | 29.55 | 29.53 |

1/ Includes Connecticut, District of Columbia, Hawaii, Massachusetts, Montana, Nebraska, New Mexico, North Dakota, Vermont, and Wisconsin.

TABLE A-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1965 - Continued

| State | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | 125 | - | 104 | 299 | 274 |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | 461 | - | 461 | - | 249 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,523 | 1,355 |
| California | - | - | - | - | - | - | - | - | - | - | - | 64 | - | 64 | 468 | 374 |
| Colorado | 171,561 | - | 150,161 | - | - | 44,774 | - | 20,112 | 11,409 | 602 | 10,061 | 170 | - | 3,119 | 335 | 1,586 |
| Delaware | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | 340 | - | 300 | 451 | 404 |
| Georgia | - | - | - | - | - | - | 2,195 | 1,732 | - | - | - | 491 | - | 491 | 1,428 | 1,231 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 31 | - | 31 | 761 | 568 |
| Illinois | - | - | - | - | - | - | 3,752 | 3,385 | 138 | - | 107 | 148 | - | 144 | 3,547 | 3,213 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 350 | 297 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 8,797 | - | 8,797 | 1,397 | 2,970 |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | 790 | - | 759 | 1,364 | 1,245 |
| Kentucky | - | - | - | - | - | - | - | - | - | - | - | 395 | - | 395 | 419 | 403 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | 23 | - | 23 | 283 | 207 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | 723 | - | 504 | 1,270 | 1,070 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 152 | - | 142 | 1,934 | 1,391 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 497 | 482 |
| Minnesota | - | - | - | - | - | - | 12,883 | 12,478 | - | - | - | - | - | - | 1,533 | 1,485 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 93 | - | 93 | 600 | 527 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 1,693 | - | 1,693 | 345 | 1,203 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | 755 | - | 755 | 2,118 | 1,624 |
| New York | - | - | - | - | - | - | - | - | - | - | - | 592 | - | 592 | 438 | 474 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | 296 | - | 296 | 1,030 | 902 |
| Ohio | - | - | - | - | - | - | - | - | 650 | 1,100 | 726 | 1,227 | - | 1,081 | 1,432 | 1,340 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 90 | - | 90 | 487 | 331 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 4,435 | - | 4,425 | 295 | 1,782 |
| Pennsylvania | 29,269 | - | 22,929 | - | - | 5,607 | 2,696 | 3,642 | 1,639 | - | 1,284 | 184 | - | 452 | 963 | 797 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 18,938 | - | 18,938 | 314 | 4,109 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 177 | - | 177 | 1,007 | 768 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 733 | - | 733 | 369 | 501 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 3,191 | - | 3,134 | 283 | 1,068 |
| Utah | 35,318 | - | 34,821 | 50,310 | - | 41,156 | - | 35,398 | 3,962 | 53,630 | 4,660 | 92 | - | 2,792 | 190 | 2,428 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 459 | - | 459 | 1,566 | 1,363 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | 586 | - | 477 | 1,689 | - | 1,088 | 131 | 251 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | 641 | - | 641 | 558 | 589 |
| Other States 1/ | - | - | - | - | - | - | - | - | - | - | - | 526 | - | 526 | 384 | 415 |
| Combined rate | 24,694 | - | 20,873 | 669 | - | 2,430 | 996 | 1,350 | 2,172 | 1,379 | 2,049 | 1,570 | - | 1,604 | 1,051 | 1,187 |

1/ Includes Connecticut, District of Columbia, Hawaii, Massachusetts, Montana, Nebraska, New Mexico, North Dakota, Vermont, and Wisconsin.

TABLE A-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1965 - Continued

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Alabama | 40 | 19 | 15 | 4 | 19 | 92 | - | 111 | 625 | 736 | 214 | 216 | - | 215 | 268 |
| Arizona | 9 | 2 | - | - | - | 28 | - | 28 | 19 | 47 | - | 194 | - | 194 | 242 |
| Arkansas | 19 | 7 | - | - | - | 45 | - | 45 | 240 | 285 | - | 178 | - | 178 | 266 |
| California | 83 | 35 | 2 | 1 | 3 | 229 | - | 232 | 699 | 931 | 20 | 205 | - | 202 | 221 |
| Colorado | 73 | 9 | 26 | 4 | 30 | 159 | - | 189 | 100 | 289 | 166 | 73 | - | 88 | 199 |
| Delaware | 1 | 1 | - | - | - | 1 | - | 1 | 12 | 13 | - | 300 | - | 300 | 318 |
| Florida | 11 | 6 | - | - | - | 66 | 10 | 76 | 173 | 249 | - | 295 | 253 | 290 | 282 |
| Georgia | 47 | 35 | - | - | - | 665 | - | 665 | 2,197 | 2,862 | - | 272 | - | 272 | 311 |
| Idaho | 10 | 4 | - | - | - | 25 | - | 25 | 46 | 71 | - | 158 | - | 158 | 239 |
| Illinois | 32 | 23 | 7 | 2 | 9 | 92 | - | 101 | 809 | 910 | 259 | 211 | - | 215 | 243 |
| Indiana | 30 | 17 | 1 | - | 1 | 93 | - | 94 | 386 | 480 | 125 | 211 | - | 210 | 259 |
| Iowa | 24 | 15 | - | - | - | 92 | - | 92 | 378 | 470 | - | 276 | - | 276 | 249 |
| Kansas | 19 | 7 | - | - | - | 44 | 1 | 45 | 165 | 210 | - | 170 | 306 | 173 | 188 |
| Kentucky | 33 | 9 | - | - | - | 228 | - | 228 | 101 | 329 | - | 231 | - | 231 | 237 |
| Louisiana | 13 | 4 | - | - | - | 51 | - | 51 | 162 | 213 | - | 294 | - | 294 | 231 |
| Maine | 7 | 4 | - | - | - | 23 | 17 | 40 | 82 | 122 | - | 154 | 93 | 128 | 179 |
| Maryland | 16 | 6 | 8 | 2 | 10 | 52 | - | 62 | 125 | 187 | 96 | 269 | - | 241 | 287 |
| Michigan | 9 | 6 | - | - | - | 12 | - | 12 | 201 | 213 | - | 149 | - | 149 | 289 |
| Minnesota | 8 | 5 | - | - | - | 10 | - | 10 | 213 | 223 | - | 189 | - | 189 | 273 |
| Mississippi | 40 | 23 | - | - | - | 153 | - | 153 | 542 | 695 | - | 163 | - | 163 | 274 |
| Missouri | 128 | 4 | - | - | - | 319 | - | 319 | 128 | 447 | - | 177 | - | 177 | 257 |
| Nevada | 4 | - | 4 | - | 4 | 8 | - | 12 | - | 12 | 52 | 57 | - | 55 | - |
| New Hampshire | 4 | - | - | - | - | 6 | - | 6 | - | 6 | - | 195 | - | 195 | - |
| New Jersey | 17 | 10 | - | - | - | 114 | - | 114 | 180 | 294 | - | 237 | - | 237 | 264 |
| New York | 16 | 11 | - | - | - | 139 | - | 139 | 407 | 546 | - | 215 | - | 215 | 239 |
| North Carolina | 37 | 17 | - | - | - | 178 | - | 178 | 890 | 1,068 | - | 245 | - | 245 | 240 |
| Ohio | 141 | 36 | 116 | 24 | 140 | 402 | 1 | 543 | 1,250 | 1,793 | 243 | 206 | 60 | 215 | 263 |
| Oklahoma | 16 | 3 | - | - | - | 108 | - | 108 | 163 | 271 | - | 220 | - | 220 | 225 |
| Oregon | 17 | 6 | - | - | - | 44 | 2 | 46 | 59 | 105 | - | 189 | 10 | 181 | 252 |
| Pennsylvania | 122 | 35 | 115 | 33 | 148 | 388 | 1 | 537 | 1,049 | 1,586 | 225 | 246 | 312 | 241 | 260 |
| South Carolina | 39 | 15 | - | - | - | 165 | - | 165 | 598 | 763 | - | 236 | - | 236 | 263 |
| South Dakota | 4 | 3 | - | - | - | 51 | - | 51 | 76 | 127 | - | 149 | - | 149 | 276 |
| Tennessee | 19 | 12 | - | - | - | 146 | - | 146 | 263 | 409 | - | 274 | - | 274 | 275 |
| Texas | 93 | 36 | - | - | - | 315 | 4 | 319 | 685 | 1,004 | - | 227 | 326 | 229 | 268 |
| Utah | 21 | 7 | 70 | 1 | 71 | 78 | - | 149 | 25 | 174 | 303 | 191 | - | 245 | 237 |
| Virginia | 18 | 6 | - | - | - | 77 | - | 77 | 269 | 346 | - | 225 | - | 225 | 294 |
| Washington | 8 | 1 | - | - | - | 18 | - | 18 | 3 | 21 | - | 60 | - | 60 | 139 |
| West Virginia | 9 | 7 | 47 | 5 | 52 | 26 | - | 78 | 353 | 431 | 126 | 256 | - | 169 | 260 |
| Wyoming | 13 | 12 | - | - | - | 163 | - | 163 | 229 | 392 | - | 229 | - | 229 | 297 |
| Other States 1/ | 40 | 12 | - | - | - | 116 | - | 116 | 234 | 350 | - | 142 | - | 142 | 251 |
| Total or average | 1,290 | 470 | 411 | 76 | 487 | 5,021 | 36 | 5,544 | 14,136 | 19,680 | 222 | 220 | 170 | 220 | 264 |

1/ Includes Connecticut, District of Columbia, Hawaii, Massachusetts, Montana, Nebraska, New Mexico, North Dakota, Vermont, and Wisconsin.

TABLE A-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1965 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | 3,162 | 912 | 4,074 | 19,838 | - | 23,912 | 167,779 | 191,691 | 25,304 | 7,297 | 32,601 | 159,793 | - | 192,394 | 1,342,241 | 1,534,635 |
| Arizona | - | - | - | 5,439 | - | 5,439 | 4,600 | 10,039 | - | - | - | 43,418 | - | 43,418 | 36,800 | 80,218 |
| Arkansas | - | - | - | 8,016 | - | 8,016 | 63,777 | 71,793 | - | - | - | 64,387 | - | 64,387 | 520,817 | 585,204 |
| California | 28 | 33 | 61 | 46,856 | - | 46,917 | 154,203 | 201,120 | 220 | 200 | 420 | 376,669 | - | 377,089 | 1,246,855 | 1,623,944 |
| Colorado | 4,370 | 623 | 4,993 | 11,588 | - | 16,581 | 19,915 | 36,496 | 34,973 | 4,984 | 39,957 | 94,048 | - | 134,005 | 164,317 | 298,322 |
| Delaware | - | - | - | 300 | - | 300 | 3,820 | 4,120 | - | - | - | 2,400 | - | 2,400 | 30,560 | 32,960 |
| Florida | - | - | - | 19,482 | 2,532 | 22,014 | 48,786 | 70,800 | - | - | - | 155,865 | 20,756 | 176,621 | 390,288 | 566,909 |
| Georgia | - | - | - | 180,785 | - | 180,785 | 683,236 | 864,021 | - | - | - | 1,462,530 | - | 1,462,530 | 5,466,002 | 6,928,532 |
| Idaho | - | - | - | 3,951 | - | 3,951 | 11,003 | 14,954 | - | - | - | 31,758 | - | 31,758 | 88,017 | 119,775 |
| Illinois | 1,810 | 520 | 2,330 | 19,392 | - | 21,722 | 196,302 | 218,024 | 14,480 | 4,160 | 18,640 | 155,164 | - | 173,804 | 1,598,970 | 1,772,774 |
| Indiana | 125 | - | 125 | 19,653 | - | 19,778 | 100,099 | 119,877 | 750 | - | 750 | 145,132 | - | 145,882 | 813,467 | 959,349 |
| Iowa | - | - | - | 25,410 | - | 25,410 | 94,206 | 119,616 | - | - | - | 208,701 | - | 208,701 | 772,988 | 981,689 |
| Kansas | - | - | - | 7,462 | 306 | 7,768 | 31,013 | 38,781 | - | - | - | 59,505 | 2,448 | 61,953 | 252,166 | 314,119 |
| Kentucky | - | - | - | 52,764 | - | 52,764 | 23,951 | 76,715 | - | - | - | 422,534 | - | 422,534 | 193,411 | 615,945 |
| Louisiana | - | - | - | 14,982 | - | 14,982 | 37,466 | 52,448 | - | - | - | 128,580 | - | 128,580 | 310,940 | 439,520 |
| Maine | - | - | - | 3,553 | 1,575 | 5,128 | 14,696 | 19,824 | - | - | - | 29,061 | 12,600 | 41,661 | 117,280 | 158,941 |
| Maryland | 768 | 192 | 960 | 14,011 | - | 14,971 | 35,875 | 50,846 | 6,145 | 1,536 | 7,681 | 112,209 | - | 119,890 | 276,108 | 395,998 |
| Michigan | - | - | - | 1,786 | - | 1,786 | 58,173 | 59,959 | - | - | - | 14,295 | - | 14,295 | 466,808 | 481,103 |
| Minnesota | - | - | - | 1,894 | - | 1,894 | 58,214 | 60,108 | - | - | - | 15,146 | - | 15,146 | 465,718 | 480,864 |
| Mississippi | - | - | - | 24,918 | - | 24,918 | 148,639 | 173,557 | - | - | - | 204,175 | - | 204,175 | 1,197,527 | 1,401,702 |
| Missouri | - | - | - | 56,407 | - | 56,407 | 32,835 | 89,242 | - | - | - | 457,211 | - | 457,211 | 261,247 | 718,458 |
| Nevada | 206 | - | 206 | 458 | - | 664 | - | 664 | 1,648 | - | 1,648 | 3,666 | - | 5,314 | - | 5,314 |
| New Hampshire | - | - | - | 1,172 | - | 1,172 | - | 1,172 | - | - | - | 8,982 | - | 8,982 | - | 8,982 |
| New Jersey | - | - | - | 26,993 | - | 26,993 | 47,507 | 74,500 | - | - | - | 215,920 | - | 215,920 | 380,141 | 596,061 |
| New York | - | - | - | 29,880 | - | 29,880 | 97,217 | 127,097 | - | - | - | 238,333 | - | 238,333 | 778,616 | 1,016,949 |
| North Carolina | - | - | - | 43,693 | - | 43,693 | 213,885 | 257,578 | - | - | - | 351,393 | - | 351,393 | 1,673,200 | 2,024,593 |
| Ohio | 28,186 | 5,797 | 33,983 | 82,674 | 60 | 116,717 | 328,603 | 445,320 | 227,860 | 46,374 | 274,234 | 668,870 | 480 | 943,584 | 2,636,564 | 3,580,148 |
| Oklahoma | - | - | - | 23,813 | - | 23,813 | 36,683 | 60,496 | - | - | - | 189,227 | - | 189,227 | 293,469 | 482,696 |
| Oregon | - | - | - | 8,325 | 20 | 8,345 | 14,851 | 23,196 | - | - | - | 66,736 | 160 | 66,896 | 118,811 | 185,707 |
| Pennsylvania | 25,986 | 7,246 | 33,232 | 95,634 | 312 | 129,178 | 273,053 | 402,231 | 204,997 | 56,685 | 261,682 | 805,753 | 2,616 | 1,070,051 | 2,225,232 | 3,295,283 |
| South Carolina | - | - | - | 38,912 | - | 38,912 | 157,083 | 195,995 | - | - | - | 322,367 | - | 322,367 | 1,259,625 | 1,581,992 |
| South Dakota | - | - | - | 7,584 | - | 7,584 | 20,970 | 28,554 | - | - | - | 67,884 | - | 67,884 | 167,760 | 235,644 |
| Tennessee | - | - | - | 39,951 | - | 39,951 | 72,271 | 112,222 | - | - | - | 332,789 | - | 332,789 | 585,979 | 918,768 |
| Texas | - | - | - | 71,626 | 1,302 | 72,928 | 183,795 | 256,723 | - | - | - | 572,573 | 10,412 | 582,985 | 1,534,356 | 2,117,341 |
| Utah | 21,235 | 303 | 21,538 | 14,935 | - | 36,473 | 5,932 | 42,405 | 169,885 | 2,424 | 172,309 | 119,261 | - | 291,570 | 47,432 | 339,002 |
| Virginia | - | - | - | 17,330 | - | 17,330 | 79,006 | 96,336 | - | - | - | 143,675 | - | 143,675 | 638,695 | 782,370 |
| Washington | - | - | - | 1,077 | - | 1,077 | 418 | 1,495 | - | - | - | 9,098 | - | 9,098 | 3,346 | 12,444 |
| West Virginia | 5,332 | 1,222 | 6,554 | 6,661 | - | 13,215 | 91,775 | 104,990 | 42,656 | 9,776 | 52,432 | 53,290 | - | 105,722 | 734,200 | 839,922 |
| Wyoming | - | - | - | 37,305 | - | 37,305 | 67,989 | 105,294 | - | - | - | 321,355 | - | 321,355 | 551,972 | 873,327 |
| Other States 1/ | - | - | - | 16,445 | - | 16,445 | 58,703 | 75,148 | - | - | - | 131,078 | - | 131,078 | 474,164 | 605,242 |
| Total | 91,208 | 16,848 | 108,056 | 1,102,955 | 6,107 | 1,217,118 | 3,738,329 | 4,955,447 | 728,918 | 133,436 | 862,354 | 8,964,831 | 49,472 | 9,876,657 | 30,116,089 | 39,992,746 |

1/ Includes Connecticut, District of Columbia, Hawaii, Massachusetts, Montana, Nebraska, New Mexico, North Dakota, Vermont, and Wisconsin.

TABLE A-15. - Injury experience and employment data by general work location at gypsum mines and mills in the United States, by State, 1965

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| California | - | - | - | - | - | - | - | - | - | - | - | 8 | - | 8 | 6 | 14 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 5 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 4 |
| Michigan | - | - | - | - | - | - | - | - | 2 | - | 2 | 1 | - | 3 | - | 3 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 |
| New York | - | - | - | - | - | - | - | - | 2 | - | 2 | - | - | 2 | 3 | 5 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 1/ | 1 | - | 1 | 1 | - | 2 | - | 2 | 3 | - | 3 | 2 | - | 5 | 2 | 7 |
| Total | 1 | - | 1 | 1 | - | 2 | - | 2 | 7 | - | 7 | 12 | - | 19 | 25 | 44 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12.83 | 10.78 |
| California | - | - | - | - | - | - | - | - | - | - | - | 40.17 | - | 40.17 | 8.00 | 14.75 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7.30 | 6.51 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3.30 | 2.86 |
| Michigan | - | - | - | - | - | - | - | - | 39.68 | - | 31.54 | 4.63 | - | 10.74 | - | 5.01 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4.12 | 3.63 |
| New York | - | - | - | - | - | - | - | - | 8.92 | - | 7.10 | - | - | 7.10 | 4.15 | 4.98 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 6.88 | - | 6.88 | - | 1.66 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 1/ | 8.45 | - | 5.48 | 3.58 | - | 4.33 | - | 1.10 | 25.35 | - | 16.45 | 7.16 | - | 10.83 | 1.47 | 3.84 |
| Combined rate | 1.46 | - | 1.19 | .86 | - | 1.00 | - | .23 | 10.22 | - | 8.30 | 10.36 | - | 9.49 | 3.81 | 5.14 |
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 590 | 496 |
| California | - | - | - | - | - | - | - | - | - | - | - | 673 | - | 673 | 2,862 | 2,402 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2,016 | 1,799 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 69 | 59 |
| Michigan | - | - | - | - | - | - | - | - | 893 | - | 710 | 111 | - | 247 | - | 115 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 14 | 12 |
| New York | - | - | - | - | - | - | - | - | 370 | - | 295 | - | - | 295 | 55 | 123 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 675 | - | 675 | - | 163 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 1/ | 50,691 | - | 32,910 | 21,475 | - | 25,990 | - | 6,586 | 262 | - | 170 | 1,682 | - | 1,085 | 77 | 333 |
| Combined rate | 8,764 | - | 7,115 | 5,181 | - | 5,996 | - | 1,402 | 232 | - | 189 | 627 | - | 442 | 588 | 554 |

1/ Includes Arkansas, Kansas, Louisiana, Montana, New Mexico, Ohio, Oklahoma, and Utah.

TABLE A-15. - Injury experience and employment data by general work location at gypsum mines and mills in the United States, by State, 1965 - Continued

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Arizona---------------------- | 5 | 3 | 2 | - | 2 | 15 | - | 17 | 70 | 87 | 100 | 234 | - | 218 | 278 |
| California------------------- | 10 | 7 | - | - | - | 86 | - | 86 | 356 | 442 | - | 268 | - | 268 | 263 |
| Colorado--------------------- | 5 | 3 | - | - | - | 17 | - | 17 | 50 | 67 | - | 165 | - | 165 | 221 |
| Indiana---------------------- | 2 | 2 | 43 | 7 | 50 | - | - | 50 | 292 | 342 | 207 | - | - | 207 | 293 |
| Iowa------------------------- | 5 | 5 | 12 | 3 | 15 | 73 | - | 88 | 460 | 548 | 249 | 267 | - | 264 | 329 |
| Michigan--------------------- | 5 | 4 | 24 | 6 | 30 | 90 | - | 120 | 153 | 273 | 253 | 291 | - | 281 | 257 |
| Nevada----------------------- | 5 | 3 | - | - | - | 46 | - | 46 | 302 | 348 | - | 265 | - | 265 | 301 |
| New York--------------------- | 5 | 3 | 110 | 28 | 138 | - | - | 138 | 327 | 465 | 255 | - | - | 255 | 272 |
| Texas------------------------ | 6 | 4 | - | - | - | 70 | - | 70 | 204 | 274 | - | 259 | - | 259 | 280 |
| Virginia--------------------- | 2 | 1 | 97 | 3 | 100 | - | - | 100 | 29 | 129 | 252 | - | - | 252 | 255 |
| Washington------------------- | - | 1 | - | - | - | - | - | - | 3 | 3 | - | - | - | - | 150 |
| Wyoming---------------------- | 1 | 2 | - | - | - | 7 | - | 7 | 8 | 15 | - | 260 | - | 260 | 225 |
| Other States 1/-------------- | 23 | 12 | 57 | 32 | 89 | 142 | - | 231 | 636 | 867 | 256 | 244 | - | 249 | 267 |
| Total or average------- | 74 | 50 | 345 | 79 | 424 | 546 | - | 970 | 2,890 | 3,860 | 248 | 260 | - | 255 | 283 |

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona---------------------- | 200 | - | 200 | 3,511 | - | 3,711 | 19,490 | 23,201 | 1,600 | - | 1,600 | 28,089 | - | 29,689 | 155,919 | 185,608 |
| California------------------- | - | - | - | 23,031 | - | 23,031 | 93,471 | 116,502 | - | - | - | 199,174 | - | 199,174 | 749,861 | 949,035 |
| Colorado--------------------- | - | - | - | 2,808 | - | 2,808 | 11,044 | 13,852 | - | - | - | 22,357 | - | 22,357 | 88,357 | 110,714 |
| Indiana---------------------- | 8,844 | 1,516 | 10,360 | - | - | 10,360 | 85,668 | 96,028 | 70,749 | 12,128 | 82,877 | - | - | 82,877 | 685,347 | 768,224 |
| Iowa------------------------- | 2,984 | 750 | 3,734 | 19,459 | - | 23,193 | 151,454 | 174,647 | 23,870 | 6,000 | 29,870 | 155,669 | - | 185,539 | 1,211,638 | 1,397,177 |
| Michigan--------------------- | 6,067 | 1,530 | 7,597 | 26,154 | - | 33,751 | 39,314 | 73,065 | 50,399 | 13,005 | 63,404 | 215,855 | - | 279,259 | 319,581 | 598,840 |
| Nevada----------------------- | - | - | - | 12,198 | - | 12,198 | 91,047 | 103,245 | - | - | - | 97,592 | - | 97,592 | 728,375 | 825,967 |
| New York--------------------- | 28,016 | 7,185 | 35,201 | - | - | 35,201 | 89,004 | 124,205 | 224,128 | 57,480 | 281,608 | - | - | 281,608 | 722,040 | 1,003,648 |
| Texas------------------------ | - | - | - | 18,159 | - | 18,159 | 57,083 | 75,242 | - | - | - | 145,275 | - | 145,275 | 456,659 | 601,934 |
| Virginia--------------------- | 24,442 | 762 | 25,204 | - | - | 25,204 | 7,399 | 32,603 | 195,545 | 6,096 | 201,641 | - | - | 201,641 | 59,190 | 260,831 |
| Washington------------------- | - | - | - | - | - | - | 450 | 450 | - | - | - | - | - | - | 3,600 | 3,600 |
| Wyoming---------------------- | - | - | - | 1,820 | - | 1,820 | 1,796 | 3,616 | - | - | - | 14,560 | - | 14,560 | 16,051 | 30,611 |
| Other States 1/-------------- | 14,796 | 7,994 | 22,790 | 34,673 | - | 57,463 | 170,026 | 227,489 | 118,365 | 63,951 | 182,316 | 279,399 | - | 461,715 | 1,360,209 | 1,821,924 |
| Total------------------ | 85,349 | 19,737 | 105,086 | 141,813 | - | 246,899 | 817,246 | 1,064,145 | 684,656 | 158,660 | 843,316 | 1,157,970 | - | 2,001,286 | 6,556,827 | 8,558,113 |

1/ Includes Arkansas, Kansas, Louisiana, Montana, New Mexico, Ohio, Oklahoma, and Utah.

TABLE A-16. - Injury experience and employment data by general work location at phosphate rock mines and mills in the United States, by State, 1965

| State | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Injuries** | | | | | | | | | | | | | | | | |
| Florida | - | - | - | - | - | - | 4 | 4 | - | - | - | 27 | 2 | 29 | 17 | 46 |
| Idaho | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 16 | - | 16 | 5 | 21 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 14 | - | 14 | 5 | 19 |
| Other States 1/ | 1 | - | 1 | - | - | 1 | - | 1 | 59 | 1 | 60 | 3 | - | 63 | 27 | 90 |
| Total | 1 | - | 1 | 1 | - | 2 | 4 | 6 | 59 | 1 | 60 | 60 | 2 | 122 | 54 | 176 |
| **Frequency rates per million man-hours** | | | | | | | | | | | | | | | | |
| Florida | - | - | - | - | - | - | 0.81 | 0.49 | - | - | - | 8.24 | 69.35 | 8.77 | 3.44 | 5.58 |
| Idaho | - | - | - | 2.01 | - | 2.01 | - | .82 | - | - | - | 32.16 | - | 32.16 | 6.90 | 17.18 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 20.54 | - | 20.54 | 27.13 | 21.94 |
| Other States 1/ | 0.86 | - | 0.73 | - | - | .68 | - | .55 | 50.49 | 5.06 | 43.92 | 27.74 | - | 42.64 | 76.53 | 49.18 |
| Combined rate | .86 | - | .73 | .22 | - | .34 | .65 | .49 | 50.49 | 5.06 | 43.92 | 13.15 | 62.81 | 20.46 | 8.71 | 14.47 |
| **Severity rates per million man-hours** | | | | | | | | | | | | | | | | |
| Florida | - | - | - | - | - | - | 4,862 | 2,912 | - | - | - | 235 | 312 | 236 | 226 | 230 |
| Idaho | - | - | - | 12,060 | - | 12,060 | - | 4,909 | - | - | - | 545 | - | 545 | 533 | 537 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 513 | - | 513 | 16,359 | 3,886 |
| Other States 1/ | 5,134 | - | 4,392 | - | - | 4,061 | - | 3,278 | 1,038 | 20 | 891 | 472 | - | 858 | 10,408 | 2,699 |
| Combined rate | 5,134 | - | 4,392 | 1,315 | - | 2,013 | 3,872 | 2,960 | 1,038 | 20 | 891 | 316 | 283 | 447 | 1,321 | 893 |

| State | Active operations: Mines | Active operations: Mills | Men employed: Underground mines: Underground | Men employed: Underground mines: Surface | Men employed: Underground mines: Total | Men employed: Open pit mines | Men employed: Other surface mining | Men employed: Total mining activities | Men employed: Mills | Men employed: Grand total | Average days active: Underground mines | Average days active: Open pit mines | Average days active: Other surface mining | Average days active: Total mining activities | Average days active: Mills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Florida | 28 | 27 | - | - | - | 1,178 | 17 | 1,195 | 1,773 | 2,968 | - | 345 | 212 | 343 | 347 |
| Idaho | 3 | 3 | - | - | - | 246 | - | 246 | 417 | 663 | - | 248 | - | 248 | 217 |
| Tennessee | 20 | 3 | - | - | - | 330 | - | 330 | 78 | 408 | - | 252 | - | 252 | 295 |
| Other States 1/ | 15 | 7 | 544 | 90 | 634 | 99 | 3 | 736 | 208 | 944 | 270 | 136 | 100 | 251 | 212 |
| Total or average | 66 | 40 | 544 | 90 | 634 | 1,853 | 20 | 2,507 | 2,476 | 4,983 | 270 | 304 | 195 | 294 | 312 |

1/ Includes Arkansas, Montana, North Carolina, Utah, and Wyoming.

TABLE A-16. - Injury experience and employment data by general work location at phosphate mines snd mills in the United States, by State, 1965 - Continued

| State | Man-days worked | | | | | | | | Msn-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Florida---------------------- | - | - | - | 405,864 | 3,605 | 409,469 | 615,629 | 1,025,098 | - | - | - | 3,277,006 | 28,840 | 3,305,846 | 4,936,394 | 8,242,240 |
| Idaho------------------------ | - | - | - | 60,930 | - | 60,930 | 90,605 | 151,535 | - | - | - | 497,528 | - | 497,528 | 724,840 | 1,222,368 |
| Tennessee-------------------- | - | - | - | 83,028 | - | 83,028 | 23,038 | 106,066 | - | - | - | 681,718 | - | 681,718 | 184,300 | 866,018 |
| Other States 1/-------------- | 146,106 | 24,785 | 170,891 | 13,457 | 300 | 184,648 | 44,100 | 228,748 | 1,168,650 | 197,555 | 1,366,205 | 108,143 | 3,000 | 1,477,348 | 352,794 | 1,830,142 |
| Total------------------------ | 146,106 | 24,785 | 170,891 | 563,279 | 3,905 | 738,075 | 773,372 | 1,511,447 | 1,168,650 | 197,555 | 1,366,205 | 4,564,395 | 31,840 | 5,962,440 | 6,198,328 | 12,160,768 |

1/ Includes Arkansas, Montana, North Carolina, Utah, and Wyoming.

TABLE A-17. - Injury experience and employment data by general work location at potash mines and mills in the United States, by State, 1965

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| California, New Mexico, snd Utah------------------ | 1 | - | 1 | - | - | 1 | - | 1 | 176 | 16 | 192 | - | - | 192 | 72 | 264 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| California, New Mexico, and Utah------------------ | 0.28 | - | 0.20 | - | - | 0.20 | - | 0.12 | 50.11 | 11.04 | 38.70 | - | - | 38.37 | 22.40 | 32.12 |
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Cslifornia, New Mexico, and Utah------------------ | 1,708 | - | 1,209 | - | - | 1,199 | - | 730 | 4,355 | 270 | 3,162 | - | - | 3,135 | 1,959 | 2,675 |

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| California, New Mexico, and Utah------------------ | 12 | 11 | 1,233 | 504 | 1,737 | - | 16 | 1,753 | 1,126 | 2,879 | 357 | - | 332 | 357 | 357 |

TABLE A-17. - Injury experience and employment data by general work location at potash mines and mills in the United States, by State, 1965 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| California, New Mexico, and Utah------------------ | 439,060 | 181,115 | 620,175 | - | 5,313 | 625,488 | 401,767 | 1,027,255 | 3,512,442 | 1,448,958 | 4,961,400 | - | 42,507 | 5,003,907 | 3,214,144 | 8,218,051 |

TABLE A-18. - Injury experience and employment data by general work location at salt mines and mills in the United States, by State, 1965

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| California------------------ | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 6 | 15 | 21 |
| Kansas---------------------- | 1 | - | 1 | - | - | 1 | - | 1 | 4 | 2 | 6 | - | - | 6 | 15 | 21 |
| Louisiana------------------- | - | - | - | - | - | - | - | - | 11 | 3 | 14 | - | - | 14 | 34 | 48 |
| Michigan-------------------- | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 13 | 15 |
| New Mexico------------------ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 |
| New York-------------------- | - | - | - | - | - | - | - | - | 30 | 6 | 36 | - | 1 | 37 | 39 | 76 |
| Ohio------------------------ | 1 | 1 | 2 | - | - | 2 | - | 2 | 22 | 1 | 23 | - | - | 23 | 17 | 40 |
| Oklahoma-------------------- | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | 1 |
| Utah------------------------ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7 | 7 |
| West Virginia--------------- | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 3 | 4 |
| Other States 1/------------- | - | - | - | - | - | - | - | - | 2 | 2 | 4 | 1 | 2 | 7 | 8 | 15 |
| Total------------------ | 2 | 1 | 3 | - | - | 3 | - | 3 | 70 | 14 | 84 | 1 | 12 | 97 | 154 | 251 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| California------------------ | - | - | - | - | - | - | - | - | - | - | - | - | 26.24 | 22.59 | 29.16 | 26.92 |
| Kansas---------------------- | 8.59 | - | 6.83 | - | - | 5.08 | - | 0.55 | 34.38 | 66.42 | 40.97 | - | - | 30.48 | 9.33 | 11.64 |
| Louisiana------------------- | - | - | - | - | - | - | - | - | 26.67 | 8.66 | 18.44 | - | - | 16.28 | 32.65 | 25.24 |
| Michigan-------------------- | - | - | - | - | - | - | - | - | 3.59 | - | 2.70 | - | 50.20 | 5.13 | 12.12 | 10.26 |
| New Mexico------------------ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 37.45 | 30.05 |
| New York-------------------- | - | - | - | - | - | - | - | - | 42.78 | 33.79 | 40.97 | - | 5.62 | 35.01 | 37.49 | 36.24 |
| Ohio------------------------ | 2.16 | 12.46 | 3.68 | - | - | 3.47 | - | 1.38 | 47.51 | 12.46 | 42.33 | - | - | 39.96 | 19.39 | 27.54 |
| Oklahoma-------------------- | - | - | - | - | - | - | - | - | - | - | - | - | 82.12 | 82.12 | - | 48.13 |
| Utah------------------------ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 25.64 | 21.38 |
| West Virginia--------------- | - | - | - | - | - | - | - | - | - | - | - | - | 22.69 | 22.69 | 1.98 | 2.56 |
| Other States 1/------------- | - | - | - | - | - | - | - | - | 35.73 | 20.93 | 26.40 | 2,272.73 | 17.00 | 25.96 | 8.55 | 12.44 |
| Combined rate---------- | .99 | 1.22 | 1.05 | - | - | .80 | - | .24 | 34.53 | 17.04 | 29.48 | 13.62 | 14.60 | 25.90 | 17.17 | 19.75 |

1/ Includes Alabama, Colorado, Nevada, North Dakota, Texas, Virginia, and Hawaii.

TABLE A-18. - Injury experience and employment data by general work location at salt mines and mills in the United States, by State, 1965 - Continued

| State | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| California | - | - | - | - | - | - | - | - | - | - | - | - | 726 | 625 | 799 | 740 |
| Kansas | 51,568 | - | 40,966 | - | - | 30,484 | - | 3,325 | 748 | 332 | 662 | - | - | 493 | 162 | 198 |
| Louisiana | - | - | - | - | - | - | - | - | 15,795 | 63 | 8,612 | - | - | 7,600 | 2,542 | 4,830 |
| Michigan | - | - | - | - | - | - | - | - | 75 | - | 57 | - | 10,441 | 588 | 381 | 436 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,872 | 1,502 |
| New York | - | - | - | - | - | - | - | - | 789 | 653 | 761 | - | 28 | 638 | 2,563 | 1,593 |
| Ohio | 12,957 | 74,745 | 22,086 | - | - | 20,849 | - | 8,262 | 549 | 237 | 502 | - | - | 474 | 644 | 577 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | - | 575 | 575 | - | 337 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 209 | 174 |
| West Virginia | - | - | - | - | - | - | - | - | - | - | - | - | 9,078 | 9,078 | 283 | 531 |
| Other States 1/ | - | - | - | - | - | - | - | - | 1,197 | 251 | 601 | 143,182 | 536 | 805 | 192 | 329 |
| Combined rate | 5,919 | 7,303 | 6,318 | - | - | 4,807 | - | 1,416 | 3,698 | 232 | 2,699 | 858 | 1,033 | 2,297 | 867 | 1,288 |

| State | Active operations: Mines | Active operations: Mills | Men employed: Underground mines: Underground | Men employed: Underground mines: Surface | Men employed: Underground mines: Total | Men employed: Open pit mines | Men employed: Other surface mining | Men employed: Total mining activities | Men employed: Mills | Men employed: Grand total | Average days active: Underground mines | Average days active: Open pit mines | Average days active: Other surface mining | Average days active: Total mining activities | Average days active: Mills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| California | 12 | 5 | - | - | - | 18 | 113 | 131 | 234 | 365 | - | 258 | 249 | 251 | 228 |
| Kansas | 6 | 8 | 47 | 12 | 59 | - | 19 | 78 | 612 | 690 | 310 | - | 331 | 315 | 329 |
| Louisiana | 17 | 6 | 183 | 158 | 341 | - | 39 | 380 | 505 | 885 | 275 | - | 324 | 280 | 257 |
| Michigan | 8 | 4 | 119 | 43 | 162 | - | 9 | 171 | 553 | 724 | 273 | - | 277 | 273 | 243 |
| New Mexico | 4 | 4 | - | - | - | 11 | - | 11 | 47 | 58 | - | 224 | - | 224 | 213 |
| New York | 6 | 4 | 296 | 75 | 371 | - | 64 | 435 | 505 | 940 | 275 | - | 348 | 286 | 257 |
| Ohio | 22 | 3 | 207 | 34 | 241 | - | 13 | 254 | 388 | 642 | 282 | - | 310 | 283 | 282 |
| Oklahoma | 2 | 1 | - | - | - | - | 5 | 5 | 3 | 8 | - | - | 282 | 282 | 300 |
| Utah | 9 | 7 | - | - | - | 9 | 22 | 31 | 144 | 175 | - | 226 | 217 | 219 | 237 |
| West Virginia | 3 | 1 | - | - | - | - | 17 | 17 | 519 | 536 | - | - | 329 | 329 | 365 |
| Other States 1/ | 18 | 5 | 28 | 46 | 74 | 2 | 49 | 125 | 399 | 524 | 256 | 28 | 301 | 270 | 293 |
| Total or average | 107 | 48 | 880 | 368 | 1,248 | 40 | 350 | 1,638 | 3,909 | 5,547 | 277 | 230 | 293 | 279 | 284 |

1/ Includes Alabama, Colorado, Nevada, North Dakota, Texas, Virginia, and Hawaii.

TABLE A-18. - Injury experience and employment data by general work location at salt mines and mills in the United States, by State, 1965 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| California---------------- | - | - | - | 4,650 | 28,181 | 32,831 | 53,285 | 86,116 | - | - | - | 37,000 | 228,645 | 265,645 | 514,349 | 779,994 |
| Kansas-------------------- | 14,544 | 3,764 | 18,308 | - | 6,295 | 24,603 | 201,343 | 225,946 | 116,352 | 30,112 | 146,464 | - | 50,360 | 196,824 | 1,607,554 | 1,804,378 |
| Louisiana----------------- | 50,560 | 43,142 | 93,702 | - | 12,633 | 106,335 | 129,782 | 236,117 | 412,476 | 346,619 | 759,095 | - | 101,062 | 860,157 | 1,041,229 | 1,901,386 |
| Michigan------------------ | 32,741 | 11,429 | 44,170 | - | 2,491 | 46,661 | 134,118 | 180,779 | 278,296 | 91,435 | 369,731 | - | 19,922 | 389,653 | 1,072.945 | 1,462,598 |
| New Mexico---------------- | - | - | - | 2,468 | - | 2,468 | 10,014 | 12,482 | - | - | - | 19,736 | - | 19,736 | 80,113 | 99,849 |
| New York------------------ | 81,178 | 20,862 | 102,040 | - | 22,241 | 124,281 | 129,601 | 253,882 | 701,195 | 177,586 | 878,781 | - | 177,932 | 1,056,713 | 1,040,234 | 2,096,947 |
| Ohio---------------------- | 57,882 | 10,034 | 67,916 | - | 4,029 | 71,945 | 109,607 | 181,552 | 463,055 | 80,273 | 543,328 | - | 32,229 | 575,557 | 876,859 | 1,452,416 |
| Oklahoma------------------ | - | - | - | - | 1,410 | 1,410 | 900 | 2,310 | - | - | - | - | 12,178 | 12,178 | 8,600 | 20,778 |
| Utah---------------------- | - | - | - | 2,032 | 4,771 | 6,803 | 34,130 | 40,933 | - | - | - | 16,256 | 38,170 | 54,426 | 273,038 | 327,464 |
| West Virginia------------- | - | - | - | - | 5,588 | 5,588 | 189,470 | 195,058 | - | - | - | - | 44,064 | 44,064 | 1,515,764 | 1,559,828 |
| Other States 1/----------- | 6,997 | 11,945 | 18,942 | 55 | 14,769 | 33,766 | 117,023 | 150,789 | 55,978 | 95,560 | 151,538 | 440 | 117,621 | 269,599 | 936,186 | 1,205,785 |
| Total----------------- | 243,902 | 101,176 | 345,078 | 9,205 | 102,408 | 456,691 | 1,109,273 | 1,565,964 | 2,027,352 | 821,585 | 2,848,937 | 73,432 | 822,183 | 3,744,552 | 8,966,871 | 12,711,423 |

1/ Includes Alabama, Colorado, Nevada, North Dakota, Texas, Virginia, and Hawaii.

TABLE A-19. - Injury experience and employment data by general work location at sulfur mines and mills in the United States, by State, 1965

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| Colorado------------------ | - | - | - | - | - | - | - | - | 4 | - | 4 | - | - | 4 | 2 | 6 |
| Louisiana----------------- | - | - | - | - | 2 | 2 | - | 2 | - | - | - | - | 20 | 20 | - | 20 |
| Texas--------------------- | - | - | - | - | - | - | - | - | - | - | - | - | 31 | 31 | - | 31 |
| Other States 1/----------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total----------------- | - | - | - | - | 2 | 2 | - | 2 | 4 | - | 4 | - | 51 | 55 | 2 | 57 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Colorado------------------ | - | - | - | - | - | - | - | - | 35.64 | - | 28.76 | - | - | 28.76 | 81.97 | 36.70 |
| Louisiana----------------- | - | - | - | - | 1.06 | 1.06 | - | 1.06 | - | - | - | - | 10.65 | 10.65 | - | 10.65 |
| Texas--------------------- | - | - | - | - | - | - | - | - | - | - | - | - | 12.66 | 12.66 | - | 12.66 |
| Other States 1/----------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Combined rate--------- | - | - | - | - | .46 | .45 | - | .45 | 35.64 | - | 28.76 | - | 11.79 | 12.32 | 81.97 | 12.69 |

1/ Includes California, and Utah.

TABLE A-19. - Injury experience and employment data by general work location at sulfur mines and mills in the United States, by State, 1965 - Continued

| State | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Colorado---------- | - | - | - | - | - | - | - | - | 285 | - | 230 | - | - | 230 | 82 | 208 |
| Louisiana---------- | - | - | - | - | 6,390 | 6,390 | - | 6,390 | - | - | - | - | 573 | 573 | - | 573 |
| Texas---------- | - | - | - | - | - | - | - | - | - | - | - | - | 252 | 252 | - | 252 |
| Other States 1/---------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Combined rate---------- | - | - | - | - | 2,774 | 2,687 | - | 2,673 | 285 | - | 230 | - | 392 | 387 | 82 | 385 |

| State | Active operations: Mines | Active operations: Mills | Men employed: Underground mines: Underground | Men employed: Underground mines: Surface | Men employed: Underground mines: Total | Men employed: Open pit mines | Men employed: Other surface mining | Men employed: Total mining activities | Men employed: Mills | Men employed: Grand total | Average days active: Underground mines | Average days active: Open pit mines | Average days active: Other surface mining | Average days active: Total mining activities | Average days active: Mills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Colorado---------- | 1 | 1 | 46 | 11 | 57 | - | - | 57 | 10 | 67 | 305 | - | - | 305 | 305 |
| Louisiana---------- | 4 | - | - | - | - | - | 474 | 474 | - | 474 | - | - | 365 | 365 | - |
| Texas---------- | 7 | - | - | - | - | - | 838 | 838 | - | 838 | - | - | 365 | 365 | - |
| Other States 1/---------- | 2 | - | - | - | - | 2 | - | 2 | - | 2 | - | 38 | - | 38 | - |
| Total or average---------- | 14 | 1 | 46 | 11 | 57 | 2 | 1,312 | 1,371 | 10 | 1,381 | 305 | 38 | 365 | 362 | 305 |

| State | Man-days worked: Underground mines: Underground | Man-days worked: Underground mines: Surface | Man-days worked: Underground mines: Total | Man-days worked: Open pit mines | Man-days worked: Other surface mining | Man-days worked: Total mining activities | Man-days worked: Mills | Man-days worked: Grand total | Man-hours worked: Underground mines: Underground | Man-hours worked: Underground mines: Surface | Man-hours worked: Underground mines: Total | Man-hours worked: Open pit mines | Man-hours worked: Other surface mining | Man-hours worked: Total mining activities | Man-hours worked: Mills | Man-hours worked: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Colorado---------- | 14,030 | 3,355 | 17,385 | - | - | 17,385 | 3,050 | 20,435 | 112,240 | 26,840 | 139,080 | - | - | 139,080 | 24,400 | 163,480 |
| Louisiana---------- | - | - | - | - | 173,343 | 173,343 | - | 173,343 | - | - | - | - | 1,878,000 | 1,878,000 | - | 1,878,000 |
| Texas---------- | - | - | - | - | 305,998 | 305,998 | - | 305,998 | - | - | - | - | 2,447,990 | 2,447,990 | - | 2,447,990 |
| Other States 1/---------- | - | - | - | 75 | - | 75 | - | 75 | - | - | - | 601 | - | 601 | - | 601 |
| Total---------- | 14,030 | 3,355 | 17,385 | 75 | 479,341 | 496,801 | 3,050 | 499,851 | 112,240 | 26,840 | 139,080 | 601 | 4,325,990 | 4,465,671 | 24,400 | 4,490,071 |

1/ Includes California, and Utah.

TABLE A-20.- Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1965

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| Arizona | - | - | - | - | - | - | 1 | 1 | 6 | - | 6 | 4 | - | 10 | 2 | 12 |
| Arkansas | - | - | - | - | - | - | - | - | 17 | - | 17 | - | - | 17 | 6 | 23 |
| California | - | - | - | 1 | - | 1 | - | 1 | 13 | 1 | 14 | 16 | - | 30 | 50 | 80 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 3 | 4 |
| Georgia | - | - | - | - | - | - | - | - | 3 | 1 | 4 | 6 | - | 10 | 6 | 16 |
| Hawaii | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| Illinois | - | - | - | - | - | - | - | - | 18 | 2 | 20 | - | - | 20 | 8 | 28 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 22 | 22 |
| Maine | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 6 | 7 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 10 | - | 10 | 42 | 52 |
| Montana | - | - | - | - | - | - | - | - | 1 | - | 1 | 7 | - | 8 | 3 | 11 |
| Nevada | - | - | - | - | - | - | - | - | 1 | - | 1 | 10 | - | 11 | 32 | 43 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | - | 2 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| New York | - | - | - | - | - | - | - | - | 10 | 1 | 11 | 2 | - | 13 | 8 | 21 |
| North Carolina | 2 | - | 2 | 1 | - | 3 | - | 3 | 1 | 1 | 2 | 6 | - | 8 | 15 | 23 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 2 | 6 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 4 | 7 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 7 | 24 | 31 |
| Vermont | - | - | - | - | - | - | - | - | 8 | 1 | 9 | - | - | 9 | 8 | 17 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 12 | 13 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | - | 2 |
| Wyoming | 1 | - | 1 | - | - | 1 | - | 1 | 9 | 1 | 10 | - | - | 10 | 4 | 14 |
| Other States 2/ | - | - | - | - | - | - | - | - | 28 | 1 | 29 | 6 | 1 | 36 | 27 | 63 |
| Total | 3 | - | 3 | 4 | - | 7 | 1 | 8 | 115 | 9 | 124 | 87 | 2 | 213 | 286 | 499 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Includes Alabama, Connecticut, Florida, Idaho, Kansas, Kentucky, Maryland, Minnesota, Mississippi, Nebraska, New Jersey, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, and Utah.

TABLE A-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1965 - Continued

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Arizona | - | - | - | - | - | - | 24.09 | 3.78 | 78.72 | - | 62.29 | 31.59 | - | 44.85 | 48.19 | 45.38 |
| Arkansas | - | - | - | - | - | - | - | - | 133.65 | - | 117.00 | - | - | 79.94 | 18.99 | 43.51 |
| California | - | - | - | 1.32 | - | 0.97 | - | .13 | 64.64 | 37.72 | 61.51 | 21.15 | - | 29.12 | 7.71 | 10.64 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | 29.46 | - | 17.50 | 24.61 | 22.34 |
| Georgia | - | - | - | - | - | - | - | - | 91.32 | 99.01 | 93.13 | 47.71 | - | 59.27 | 15.18 | 28.38 |
| Hawaii | - | - | - | 22.94 | - | 22.94 | - | 14.59 | - | - | - | - | - | - | - | - |
| Illinois | - | - | - | - | - | - | - | - | 40.85 | 18.44 | 36.42 | - | - | 36.42 | 16.12 | 26.79 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 73.74 | 73.74 |
| Maine | - | - | - | 54.95 | - | 53.08 | - | 42.85 | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | 24.99 | 24.99 | 8.25 | 9.12 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 17.66 | - | 17.66 | 62.46 | 41.98 |
| Montana | - | - | - | - | - | - | - | - | 107.62 | - | 90.61 | 37.16 | - | 40.12 | 13.35 | 25.93 |
| Nevada | - | - | - | - | - | - | - | - | 48.31 | - | 43.29 | 39.25 | - | 39.58 | 53.39 | 49.02 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 84.58 | - | 84.58 | - | 84.58 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 14.73 | 10.06 |
| New York | - | - | - | - | - | - | - | - | 45.10 | 35.77 | 44.05 | 39.65 | - | 43.31 | 13.31 | 23.30 |
| North Carolina | 11.84 | - | 9.26 | 3.46 | - | 5.92 | - | 2.57 | 5.92 | 21.30 | 9.26 | 20.79 | - | 15.79 | 22.74 | 19.72 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 47.07 | - | 47.07 | 96.88 | 56.81 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 20.43 | - | 20.43 | 16.21 | 17.79 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 73.01 | - | 48.98 | 47.73 | 48.01 |
| Vermont | - | - | - | - | - | - | - | - | 96.40 | 109.31 | 97.68 | - | - | 39.40 | 17.83 | 25.10 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 9.16 | - | 9.16 | 34.23 | 28.28 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 22.72 | - | 22.70 | - | 12.56 |
| Wyoming | 1.58 | - | 1.22 | - | - | 1.18 | - | .57 | 14.20 | 5.47 | 12.25 | - | - | 11.80 | 4.36 | 7.93 |
| Other States 2/ | - | - | - | - | - | - | - | - | 106.59 | 40.03 | 100.81 | 12.43 | 142.01 | 46.30 | 17.61 | 27.26 |
| Combined rate | 1.31 | - | 1.08 | 1.07 | - | 1.04 | .06 | .35 | 50.10 | 18.53 | 44.58 | 23.28 | 10.64 | 31.76 | 17.99 | 22.08 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Includes Alabama, Connecticut, Florida, Idaho, Kansas, Kentucky, Maryland, Minnesota, Mississippi, Nebraska, New Jersey, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, and Utah.

TABLE A-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1965 - Continued

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Arizona | - | - | - | - | - | - | 144,564 | 22,688 | 813 | - | 644 | 505 | - | 565 | 72 | 488 |
| Arkansas | - | - | - | - | - | - | - | - | 1,667 | - | 1,459 | - | - | 997 | 373 | 624 |
| California | - | - | - | 7,931 | - | 5,823 | - | 798 | 830 | 264 | 764 | 846 | - | 790 | 362 | 421 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | 412 | - | 245 | 681 | 542 |
| Georgia | - | - | - | - | - | - | - | - | 578 | 33,267 | 8,265 | 1,161 | - | 2,970 | 476 | 1,222 |
| Hawaii | - | - | - | 137,643 | - | 137,643 | - | 87,563 | - | - | - | - | - | - | - | - |
| Illinois | - | - | - | - | - | - | - | - | 2,331 | 1,899 | 2,246 | - | - | 2,246 | 482 | 1,408 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2,306 | 2,306 |
| Maine | - | - | - | 329,707 | - | 318,505 | - | 257,091 | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | 1,574 | 1,574 | 4,283 | 4,142 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 274 | - | 274 | 1,017 | 677 |
| Montana | - | - | - | - | - | - | - | - | 8,932 | - | 7,521 | 536 | - | 923 | 271 | 578 |
| Nevada | - | - | - | - | - | - | - | - | 217,391 | - | 194,805 | 408 | - | 16,567 | 2,202 | 6,753 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 973 | - | 973 | - | 973 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 22,111 | 15,102 |
| New York | - | - | - | - | - | - | - | - | 1,569 | 358 | 1,434 | 37,037 | - | 7,417 | 318 | 2,682 |
| North Carolina | 71,024 | - | 55,581 | 20,789 | - | 35,532 | - | 15,436 | 6 | 682 | 153 | 270 | - | 219 | 2,832 | 1,697 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 965 | - | 965 | 4,020 | 1,562 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 109 | - | 109 | 490 | 348 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 17,878 | - | 11,993 | 1,543 | 3,856 |
| Vermont | - | - | - | - | - | - | - | - | 3,254 | 1,093 | 3,039 | - | - | 1,226 | 13,503 | 9,362 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 128 | - | 128 | 810 | 648 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 636 | - | 636 | - | 352 |
| Wyoming | 9,466 | - | 7,348 | - | - | 7,081 | - | 3,401 | 297 | 5 | 231 | - | - | 223 | 182 | 202 |
| Other States 2/ | - | - | - | - | - | - | - | - | 1,858 | 160 | 1,710 | 12,617 | 284 | 8,470 | 1,207 | 3,651 |
| Combined rate | 7,842 | - | 6,472 | 6,423 | - | 6,263 | 377 | 2,124 | 3,209 | 1,247 | 2,866 | 2,989 | 346 | 2,864 | 1,463 | 1,878 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Includes Alabama, Connecticut, Florida, Idaho, Kansas, Kentucky, Maryland, Minnesota, Mississippi, Nebraska, New Jersey, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, and Utah.

TABLE A-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1965 - Continued

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Arizona | 25 | 5 | 33 | 9 | 42 | 92 | - | 134 | 25 | 159 | 287 | 171 | - | 207 | 204 |
| Arkansas | 10 | 4 | 65 | 9 | 74 | 31 | 9 | 114 | 149 | 263 | 245 | 203 | 235 | 233 | 265 |
| California | 117 | 47 | 108 | 12 | 120 | 402 | 22 | 544 | 2,611 | 3,155 | 238 | 235 | 252 | 236 | 310 |
| Colorado | 27 | 5 | 8 | 3 | 11 | 35 | - | 46 | 58 | 104 | 264 | 121 | - | 155 | 263 |
| Georgia | 13 | 6 | 13 | 4 | 17 | 69 | - | 86 | 157 | 243 | 253 | 227 | - | 232 | 300 |
| Hawaii | 23 | 5 | - | - | - | 70 | - | 70 | 45 | 115 | - | 82 | - | 82 | 69 |
| Illinois | 25 | 7 | 223 | 50 | 273 | - | - | 273 | 216 | 489 | 251 | - | - | 251 | 287 |
| Indiana | 1 | 1 | - | - | - | 3 | - | 3 | 2 | 5 | - | 2 | - | 2 | 50 |
| Louisiana | - | 5 | - | - | - | - | - | - | 134 | 134 | - | - | - | - | 278 |
| Maine | 10 | 1 | 1 | - | 1 | 14 | - | 15 | 2 | 17 | 80 | 146 | - | 142 | 250 |
| Michigan | 32 | 3 | - | - | - | - | 18 | 18 | 320 | 338 | - | - | 278 | 278 | 284 |
| Missouri | 19 | 20 | - | - | - | 264 | - | 264 | 316 | 580 | - | 264 | - | 264 | 260 |
| Montana | 13 | 5 | 6 | 1 | 7 | 99 | - | 106 | 98 | 204 | 197 | 237 | - | 234 | 287 |
| Nevada | 41 | 12 | 15 | 1 | 16 | 122 | - | 138 | 270 | 408 | 183 | 251 | - | 243 | 277 |
| New Hampshire | 3 | - | - | - | - | 17 | - | 17 | - | 17 | - | 174 | - | 174 | - |
| New Mexico | 19 | 10 | - | - | - | 46 | - | 46 | 64 | 110 | - | 172 | - | 172 | 265 |
| New York | 10 | 11 | 94 | 12 | 106 | 35 | - | 141 | 283 | 424 | 282 | 180 | - | 256 | 256 |
| North Carolina | 53 | 17 | 83 | 24 | 107 | 153 | 2 | 262 | 288 | 550 | 252 | 234 | 130 | 241 | 286 |
| Oregon | 9 | 3 | - | - | - | 50 | - | 50 | 11 | 61 | - | 212 | - | 212 | 235 |
| South Carolina | 7 | 6 | - | - | - | 63 | - | 63 | 105 | 168 | - | 278 | - | 278 | 285 |
| Texas | 15 | 11 | - | - | - | 63 | 18 | 81 | 197 | 278 | - | 190 | 327 | 221 | 316 |
| Vermont | 4 | 5 | 34 | 4 | 38 | 68 | - | 106 | 189 | 295 | 298 | 251 | - | 268 | 296 |
| Virginia | 8 | 7 | - | - | - | 54 | - | 54 | 148 | 202 | - | 247 | - | 247 | 296 |
| Washington | 15 | 4 | - | - | - | 59 | 1 | 60 | 45 | 105 | - | 187 | 10 | 184 | 198 |
| Wyoming | 18 | 3 | 235 | 67 | 302 | 3 | 11 | 316 | 316 | 632 | 339 | 89 | 325 | 336 | 363 |
| Other States 2/ | 87 | 22 | 116 | 11 | 127 | 294 | 3 | 424 | 619 | 1,043 | 283 | 203 | 293 | 227 | 306 |
| Total or average | 604 | 225 | 1,034 | 207 | 1,241 | 2,106 | 84 | 3,431 | 6,668 | 10,099 | 278 | 219 | 277 | 242 | 296 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Includes Alabama, Connecticut, Florida, Idaho, Kansas, Kentucky, Maryland, Minnesota, Mississippi, Nebraska, New Jersey, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, and Utah.

TABLE A-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1965 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona | 9,528 | 2,513 | 12,041 | 15,742 | - | 27,783 | 5,110 | 32,893 | 76,221 | 20,104 | 96,325 | 126,624 | - | 222,949 | 41,504 | 264,453 |
| Arkansas | 15,900 | 2,262 | 18,162 | 6,297 | 2,114 | 26,573 | 39,500 | 66,073 | 127,195 | 18,099 | 145,294 | 50,461 | 16,915 | 212,670 | 316,003 | 528,673 |
| California | 25,138 | 3,439 | 28,577 | 94,290 | 5,534 | 128,401 | 810,544 | 938,945 | 201,105 | 26,512 | 227,617 | 756,527 | 46,194 | 1,030,338 | 6,487,115 | 7,517,453 |
| Colorado | 2,072 | 828 | 2,900 | 4,241 | - | 7,141 | 15,258 | 22,399 | 16,573 | 6,622 | 23,195 | 33,944 | - | 57,139 | 121,924 | 179,063 |
| Georgia | 3,285 | 1,010 | 4,295 | 15,694 | - | 19,989 | 47,035 | 67,024 | 32,850 | 10,100 | 42,950 | 125,758 | - | 168,708 | 395,144 | 563,852 |
| Hawaii | - | - | - | 5,710 | - | 5,710 | 3,116 | 8,826 | - | - | - | 43,591 | - | 43,591 | 24,931 | 68,522 |
| Illinois | 54,982 | 13,554 | 68,536 | - | - | 68,536 | 62,028 | 130,564 | 440,637 | 108,451 | 549,088 | - | - | 549,088 | 496,220 | 1,045,308 |
| Indiana | - | - | - | 6 | - | 6 | 100 | 106 | - | - | - | 48 | - | 48 | 802 | 850 |
| Louisiana | - | - | - | - | - | - | 37,294 | 37,294 | - | - | - | - | - | - | 298,352 | 298,352 |
| Maine | 80 | - | 80 | 2,048 | - | 2,128 | 500 | 2,628 | 640 | - | 640 | 18,198 | - | 18,838 | 4,500 | 23,338 |
| Michigan | - | - | - | - | 5,001 | 5,001 | 90,955 | 95,956 | - | - | - | - | 40,020 | 40,020 | 727,563 | 767,583 |
| Missouri | - | - | - | 69,599 | - | 69,599 | 82,159 | 151,758 | - | - | - | 566,189 | - | 566,189 | 672,388 | 1,238,577 |
| Montana | 1,162 | 218 | 1,380 | 23,425 | - | 24,805 | 28,123 | 52,928 | 9,292 | 1,744 | 11,036 | 188,358 | - | 199,394 | 224,780 | 424,174 |
| Nevada | 2,625 | 300 | 2,925 | 30,569 | - | 33,494 | 74,862 | 108,356 | 20,700 | 2,400 | 23,100 | 254,797 | - | 277,897 | 599,351 | 877,248 |
| New Hampshire | - | - | - | 2,956 | - | 2,956 | - | 2,956 | - | - | - | 23,647 | - | 23,647 | - | 23,647 |
| New Mexico | - | - | - | 7,901 | - | 7,901 | 16,976 | 24,877 | - | - | - | 63,029 | - | 63,029 | 135,815 | 198,844 |
| New York | 26,547 | 3,308 | 29,855 | 6,305 | - | 36,160 | 72,560 | 108,720 | 221,742 | 27,960 | 249,702 | 50,436 | - | 300,138 | 601,107 | 901,245 |
| North Carolina | 21,120 | 5,868 | 26,988 | 35,823 | 260 | 63,071 | 82,438 | 145,509 | 168,957 | 46,944 | 215,901 | 288,611 | 2,080 | 506,592 | 659,515 | 1,166,107 |
| Oregon | - | - | - | 10,622 | - | 10,622 | 2,580 | 13,202 | - | - | - | 84,977 | - | 84,977 | 20,645 | 105,622 |
| South Carolina | - | - | - | 17,527 | - | 17,527 | 29,930 | 47,457 | - | - | - | 146,819 | - | 146,819 | 246,746 | 393,565 |
| Texas | - | - | - | 11,985 | 5,881 | 17,866 | 62,282 | 80,148 | - | - | - | 95,871 | 47,048 | 142,919 | 502,847 | 645,766 |
| Vermont | 10,218 | 1,112 | 11,330 | 17,038 | - | 28,368 | 55,880 | 84,248 | 82,987 | 9,148 | 92,135 | 136,302 | - | 228,437 | 448,784 | 677,221 |
| Virginia | - | - | - | 13,339 | - | 13,339 | 43,816 | 57,155 | - | - | - | 109,189 | - | 109,189 | 350,523 | 459,712 |
| Washington | - | - | - | 11,008 | 10 | 11,018 | 8,890 | 19,908 | - | - | - | 88,033 | 80 | 88,113 | 71,120 | 159,233 |
| Wyoming | 79,233 | 23,113 | 102,346 | 266 | 3,578 | 106,190 | 114,639 | 220,829 | 633,862 | 182,742 | 816,604 | 2,128 | 28,605 | 847,337 | 917,106 | 1,764,443 |
| Other States 2/ | 32,835 | 3,123 | 35,958 | 59,552 | 880 | 96,390 | 189,220 | 285,610 | 262,683 | 24,984 | 287,667 | 482,828 | 7,042 | 777,537 | 1,533,476 | 2,311,013 |
| Total | 284,725 | 60,648 | 345,373 | 461,943 | 23,258 | 830,574 | 1,975,795 | 2,806,369 | 2,295,444 | 485,810 | 2,781,254 | 3,736,365 | 187,984 | 6,705,603 | 15,898,261 | 22,603,864 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Includes Alabama, Connecticut, Florida, Idaho, Kansas, Kentucky, Maryland, Minnesota, Mississippi, Nebraska, New Jersey, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, and Utah.

TABLE A-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1965

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Injuries | | | | | | | | | | | | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 21 | 25 |
| Arizona | - | - | - | - | - | - | 1 | 1 | 6 | - | 6 | 9 | - | 15 | 4 | 19 |
| Arkansas | - | - | - | - | - | - | - | - | 17 | - | 17 | - | - | 17 | 30 | 47 |
| California | - | - | - | 1 | - | 1 | - | 1 | 13 | 1 | 14 | 26 | 6 | 46 | 118 | 164 |
| Colorado | 1 | - | 1 | - | - | 1 | - | 1 | 8 | 1 | 9 | 2 | - | 11 | 10 | 21 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Florida | - | - | - | - | - | - | 4 | 4 | - | - | - | 28 | 2 | 30 | 30 | 60 |
| Georgia | - | - | - | - | - | - | 2 | 2 | 3 | 1 | 4 | 42 | - | 46 | 127 | 173 |
| Hawaii | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| Idaho | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 18 | - | 18 | 10 | 28 |
| Illinois | - | - | - | - | - | - | 1 | 1 | 19 | 2 | 21 | 5 | - | 26 | 57 | 83 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 32 | 32 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 25 | 28 |
| Kansas | 1 | - | 1 | - | - | 1 | - | 1 | 5 | 2 | 7 | 2 | - | 9 | 40 | 49 |
| Kentucky | - | - | - | - | - | - | - | - | 27 | 1 | 28 | 10 | - | 38 | 8 | 46 |
| Louisiana | - | - | - | - | 2 | 2 | - | 2 | 11 | 3 | 14 | 1 | 20 | 35 | 64 | 99 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 22 | 23 |
| Michigan | - | - | - | - | - | - | - | - | 3 | - | 3 | 1 | 2 | 6 | 25 | 31 |
| Minnesota | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | 33 | 33 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 43 | 46 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 19 | - | 19 | 44 | 63 |
| Montana | 2 | - | 2 | - | - | 2 | - | 2 | 18 | - | 18 | 7 | - | 25 | 6 | 31 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | 1 | - | 1 | 11 | - | 12 | 35 | 47 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | - | 2 |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | 9 | 1 | 10 | 17 | 27 |
| New Mexico | - | - | - | - | - | - | - | - | 170 | 13 | 183 | - | - | 183 | 72 | 255 |
| New York | - | - | - | - | - | - | - | - | 42 | 7 | 49 | 9 | 1 | 59 | 80 | 139 |
| North Carolina | 2 | - | 2 | 1 | - | 3 | - | 3 | 1 | 1 | 2 | 13 | - | 15 | 76 | 91 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Ohio | 1 | 1 | 2 | - | - | 2 | - | 2 | 34 | 4 | 38 | 9 | - | 47 | 78 | 125 |
| Oklahoma | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 3 | 1 | 4 | 9 | 13 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 13 | - | 13 | 6 | 19 |
| Pennsylvania | 1 | - | 1 | - | - | 1 | 1 | 2 | 11 | - | 11 | 8 | - | 19 | 116 | 135 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 12 | - | 12 | 23 | 35 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 7 | 10 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 28 | - | 28 | 18 | 46 |
| Texas | - | - | - | - | - | - | - | - | 2 | 2 | 4 | 48 | 33 | 85 | 70 | 155 |
| Utah | 2 | - | 2 | 1 | - | 3 | - | 3 | 79 | 11 | 90 | 3 | - | 93 | 18 | 111 |
| Vermont | - | - | - | - | - | - | - | - | 8 | 1 | 9 | 1 | - | 10 | 12 | 22 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 5 | - | 5 | 42 | 47 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | - | 2 |
| West Virginia | - | - | - | - | - | - | - | - | 3 | - | 3 | 1 | 1 | 5 | 12 | 17 |
| Wyoming | 1 | - | 1 | - | - | 1 | - | 1 | 9 | 1 | 10 | 14 | - | 24 | 26 | 50 |
| Other States 1/ | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 6 | - | 6 | 14 | 20 |
| Total | 11 | 1 | 12 | 7 | 2 | 21 | 10 | 31 | 490 | 51 | 541 | 381 | 67 | 989 | 1,483 | 2,472 |

1/ Includes Delaware, District of Columbia, Maine, Massachusetts, and Wisconsin.

TABLE A-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1965 - Continued

| State | Fatal | | | | | | | | Nonfatal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | 20.64 | - | 16.89 | 11.30 | 11.93 |
| Arizona | - | - | - | - | - | - | 4.27 | 1.89 | 77.10 | - | 61.27 | 45.42 | - | 50.67 | 17.08 | 35.83 |
| Arkansas | - | - | - | - | - | - | - | - | 133.65 | - | 117.00 | - | - | 50.97 | 28.90 | 34.26 |
| California | - | - | - | 0.73 | - | 0.53 | - | .09 | 64.57 | 37.44 | 61.39 | 18.99 | 21.83 | 24.57 | 13.06 | 15.04 |
| Colorado | 6.11 | - | 4.94 | - | - | 2.83 | - | 1.33 | 48.84 | 26.01 | 44.50 | 13.30 | - | 31.18 | 25.06 | 27.93 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21.56 | 8.34 |
| Florida | - | - | - | - | - | - | .73 | .45 | - | - | - | 8.16 | 40.33 | 8.61 | 5.48 | 6.70 |
| Georgia | - | - | - | - | - | - | .34 | .27 | 91.32 | 99.01 | 93.13 | 26.44 | - | 28.20 | 21.67 | 23.09 |
| Hawaii | - | - | - | 22.90 | - | 22.29 | - | 14.33 | - | - | - | - | - | - | - | - |
| Idaho | - | - | - | 1.79 | - | 1.79 | - | .72 | - | - | - | 32.18 | - | 32.18 | 12.07 | 20.18 |
| Illinois | - | - | - | - | - | - | .48 | .35 | 41.75 | 17.76 | 36.99 | 32.22 | - | 35.97 | 27.21 | 29.45 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21.34 | 18.51 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 8.23 | - | 7.61 | 12.60 | 11.77 |
| Kansas | 5.84 | - | 4.51 | - | - | 2.85 | - | .37 | 29.22 | 39.61 | 31.59 | 26.23 | - | 25.67 | 17.13 | 18.25 |
| Kentucky | - | - | - | - | - | - | - | - | 105.35 | 40.03 | 99.55 | 23.67 | - | 53.99 | 30.34 | 47.55 |
| Louisiana | - | - | - | - | 1.01 | .69 | - | .44 | 26.67 | 8.66 | 18.44 | 6.66 | 10.11 | 12.12 | 38.23 | 21.70 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 7.99 | - | 7.53 | 71.98 | 52.45 |
| Michigan | - | - | - | - | - | - | - | - | 9.13 | - | 6.93 | 4.34 | 33.37 | 8.30 | 9.66 | 9.37 |
| Minnesota | - | - | - | - | - | - | 2.15 | 2.07 | - | - | - | - | - | - | 70.86 | 68.20 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 14.69 | - | 14.69 | 23.86 | 22.92 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 18.57 | - | 18.57 | 47.13 | 32.19 |
| Montana | 2.01 | - | 1.66 | - | - | 1.43 | - | 1.09 | 18.10 | - | 14.95 | 35.55 | - | 17.85 | 14.02 | 16.95 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | 44.75 | - | 40.41 | 30.86 | - | 31.48 | 26.36 | 27.50 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 61.30 | - | 61.30 | - | 61.30 |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | 41.68 | 142.01 | 44.85 | 25.63 | 30.46 |
| New Mexico | - | - | - | - | - | - | - | - | 52.95 | 10.30 | 40.92 | - | - | 40.01 | 21.18 | 31.98 |
| New York | - | - | - | - | - | - | - | - | 36.62 | 26.61 | 34.75 | 31.17 | 5.62 | 31.44 | 25.46 | 27.70 |
| North Carolina | 11.84 | - | 9.26 | 1.51 | - | 3.41 | - | .91 | 5.92 | 21.30 | 9.26 | 19.63 | - | 17.04 | 31.45 | 27.61 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 16.87 | 13.69 |
| Ohio | 1.36 | 7.16 | 2.28 | - | - | 1.23 | - | .39 | 46.18 | 28.63 | 43.38 | 12.63 | - | 28.99 | 22.08 | 24.25 |
| Oklahoma | - | - | - | 2.88 | - | 2.78 | - | 1.45 | - | - | - | 8.63 | 82.12 | 11.12 | 27.32 | 18.86 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 85.69 | - | 85.60 | 43.02 | 65.22 |
| Pennsylvania | 4.88 | - | 3.82 | - | - | .93 | .45 | .60 | 53.66 | - | 42.04 | 9.80 | - | 17.59 | 52.06 | 40.80 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 25.58 | - | 25.58 | 15.27 | 17.72 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 14.32 | - | 14.32 | 25.12 | 20.48 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 25.69 | - | 25.69 | 22.87 | 24.51 |
| Texas | - | - | - | - | - | - | - | - | 35.73 | 20.93 | 26.40 | 58.99 | 12.72 | 23.88 | 23.52 | 23.72 |
| Utah | 2.94 | - | 2.25 | 4.99 | - | 2.56 | - | 1.37 | 116.12 | 52.50 | 101.14 | 14.98 | - | 79.43 | 17.77 | 50.83 |
| Vermont | - | - | - | - | - | - | - | - | 96.40 | 109.31 | 97.68 | 7.02 | - | 42.62 | 25.14 | 30.90 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 19.77 | - | 10.79 | 39.35 | 30.71 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 20.59 | - | 20.57 | - | 11.41 |
| West Virginia | - | - | - | - | - | - | - | - | 70.33 | - | 57.22 | 18.77 | 22.69 | 33.38 | 5.33 | 7.08 |
| Wyoming | 1.58 | - | 1.22 | - | - | .81 | - | .35 | 14.20 | 5.47 | 12.25 | 36.07 | - | 19.41 | 16.02 | 17.48 |
| Other States 1/ | - | - | - | 9.41 | - | 8.37 | - | 1.75 | - | - | - | 56.48 | - | 50.22 | 31.01 | 35.03 |
| Combined rate | 1.04 | .31 | .87 | .38 | .37 | .56 | .14 | .29 | 46.54 | 15.58 | 39.20 | 20.60 | 12.27 | 26.19 | 20.89 | 22.73 |

1/ Includes Delaware, District of Columbia, Maine, Massachusetts, and Wisconsin.

TABLE A-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1965 - Continued

| State | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Severity rates per million man-hours | | | | | | | | | | | | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | - | - | 31,218 | - | 25,550 | 219 | 3,082 |
| Arizona | - | - | - | - | - | - | 25,617 | 11,315 | 797 | - | 633 | 424 | - | 493 | 406 | 454 |
| Arkansas | - | - | - | - | - | - | - | - | 1,667 | - | 1,459 | - | - | 636 | 878 | 819 |
| California | - | - | - | 4,381 | - | 3,205 | - | 550 | 830 | 262 | 763 | 583 | 604 | 608 | 609 | 609 |
| Colorado | 36,633 | - | 29,669 | - | - | 17,005 | - | 7,980 | 2,631 | 78 | 2,146 | 200 | - | 1,315 | 351 | 803 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 323 | 125 |
| Florida | - | - | - | - | - | - | 4,384 | 2,679 | - | - | - | 240 | 181 | 239 | 248 | 244 |
| Georgia | - | - | - | - | - | - | 2,047 | 1,602 | 578 | 33,267 | 8,265 | 544 | - | 747 | 1,364 | 1,230 |
| Hawaii | - | - | - | 137,391 | - | 133,717 | - | 85,957 | - | - | - | - | - | - | - | - |
| Idaho | - | - | - | 10,726 | - | 10,726 | - | 4,324 | - | - | - | 522 | - | 522 | 547 | 537 |
| Illinois | - | - | - | - | - | - | 2,864 | 2,129 | 2,261 | 1,829 | 2,175 | 148 | - | 1,740 | 2,821 | 2,544 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,112 | 964 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 5,039 | - | 4,657 | 586 | 1,261 |
| Kansas | 35,066 | - | 27,075 | - | - | 17,111 | - | 2,234 | 526 | 198 | 451 | 617 | - | 419 | 286 | 303 |
| Kentucky | - | - | - | - | - | - | - | - | 1,885 | 160 | 1,731 | 395 | - | 929 | 326 | 765 |
| Louisiana | - | - | - | - | 6,063 | 4,155 | - | 2,630 | 15,795 | 63 | 8,612 | 20 | 544 | 2,637 | 2,044 | 2,419 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 136 | - | 128 | 1,803 | 1,295 |
| Michigan | - | - | - | - | - | - | - | - | 201 | - | 152 | 104 | 4,521 | 499 | 1,452 | 1,244 |
| Minnesota | - | - | - | - | - | - | 12,883 | 12,400 | - | - | - | - | - | - | 1,533 | 1,476 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 93 | - | 93 | 1,302 | 1,179 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 908 | - | 908 | 829 | 870 |
| Montana | 12,070 | - | 9,970 | - | - | 8,568 | - | 6,563 | 869 | - | 718 | 513 | - | 689 | 407 | 623 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | 20,136 | - | 181,833 | 468 | - | 12,242 | 1,002 | 3,509 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 705 | - | 705 | - | 705 |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | 755 | 284 | 740 | 1,319 | 1,173 |
| New Mexico | - | - | - | - | - | - | - | - | 2,800 | 303 | 2,095 | - | - | 2,049 | 2,735 | 2,341 |
| New York | - | - | - | - | - | - | - | - | 858 | 479 | 787 | 6,957 | 28 | 1,665 | 1,031 | 1,268 |
| North Carolina | 71,024 | - | 55,581 | 9,061 | - | 20,451 | - | 5,461 | 6 | 682 | 153 | 275 | - | 244 | 1,640 | 1,267 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 287 | 233 |
| Ohio | 8,149 | 42,946 | 13,699 | - | - | 7,403 | - | 2,328 | 546 | 501 | 539 | 1,181 | - | 810 | 1,229 | 1,097 |
| Oklahoma | - | - | - | 17,265 | - | 16,680 | - | 8,706 | - | - | - | 1,401 | 575 | 1,373 | 434 | 924 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 2,492 | - | 2,489 | 846 | 1,703 |
| Pennsylvania | 29,269 | - | 22,929 | - | - | 5,553 | 2,693 | 3,627 | 1,639 | - | 1,284 | 181 | - | 448 | 962 | 794 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 13,046 | - | 13,046 | 343 | 3,360 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 158 | - | 158 | 721 | 479 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 545 | - | 545 | 4,105 | 2,038 |
| Texas | - | - | - | - | - | - | - | - | 1,197 | 251 | 601 | 4,472 | 263 | 1,239 | 461 | 885 |
| Utah | 17,638 | - | 13,486 | 29,962 | - | 15,374 | - | 8,243 | 10,946 | 683 | 8,530 | 60 | - | 6,493 | 263 | 3,603 |
| Vermont | - | - | - | - | - | - | - | - | 3,254 | 1,093 | 3,039 | 21 | - | 1,206 | 12,745 | 8,942 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 316 | - | 173 | 1,203 | 891 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 577 | - | 576 | - | 319 |
| West Virginia | - | - | - | - | - | - | - | - | 586 | - | 477 | 1,689 | 9,078 | 3,438 | 233 | 433 |
| Wyoming | 9,466 | - | 7,348 | - | - | 4,853 | - | 2,098 | 297 | 5 | 231 | 660 | - | 360 | 2,277 | 1,448 |
| Other States 1/ | - | - | - | 56,483 | - | 50,223 | - | 10,508 | - | - | - | 819 | - | 728 | 549 | 587 |
| Combined rate | 6,268 | 1,833 | 5,216 | 2,271 | 2,198 | 3,337 | 845 | 1,711 | 3,148 | 420 | 2,501 | 1,485 | 479 | 1,711 | 1,141 | 1,339 |

1/ Includes Delaware, District of Columbia, Maine, Massachusetts, and Wisconsin.

TABLE A-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1965 - Continued

| State | Active operations: Underground mines | Active operations: Surface mines | Active operations: Mills | Men employed: Underground mines: Underground | Men employed: Underground mines: Surface | Men employed: Underground mines: Total | Men employed: Open pit mines | Men employed: Other surface mining | Men employed: Total mining activities | Men employed: Mills | Men employed: Grand total | Average days active: Underground mines | Average days active: Open pit mines | Average days active: Other surface mining | Average days active: Total mining activities | Average days active: Mills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 3 | 41 | 22 | 15 | 4 | 19 | 108 | 5 | 132 | 811 | 943 | 214 | 219 | 260 | 220 | 287 |
| Arizona | 5 | 34 | 10 | 35 | 9 | 44 | 135 | - | 179 | 114 | 293 | 278 | 183 | - | 206 | 256 |
| Arkansas | 2 | 32 | 14 | 65 | 9 | 74 | 106 | 9 | 189 | 478 | 667 | 245 | 199 | 235 | 219 | 269 |
| California | 26 | 197 | 95 | 110 | 13 | 123 | 736 | 135 | 994 | 3,920 | 4,914 | 233 | 229 | 250 | 233 | 285 |
| Colorado | 10 | 97 | 18 | 80 | 18 | 98 | 211 | 1 | 310 | 218 | 528 | 258 | 88 | 32 | 142 | 226 |
| Connecticut | - | 6 | 3 | - | - | - | 64 | - | 64 | 41 | 105 | - | 286 | - | 286 | 283 |
| Florida | - | 39 | 34 | - | - | - | 1,244 | 27 | 1,271 | 1,996 | 3,267 | - | 342 | 227 | 339 | 342 |
| Georgia | 2 | 58 | 41 | 13 | 4 | 17 | 734 | - | 751 | 2,354 | 3,105 | 253 | 268 | - | 267 | 310 |
| Hawaii | - | 25 | 5 | - | - | - | 71 | 1 | 72 | 45 | 117 | - | 81 | 300 | 84 | 69 |
| Idaho | - | 22 | 9 | - | - | - | 298 | - | 298 | 471 | 769 | - | 230 | - | 230 | 220 |
| Illinois | 26 | 31 | 30 | 230 | 52 | 282 | 92 | - | 374 | 1,025 | 1,399 | 251 | 211 | - | 241 | 252 |
| Indiana | 3 | 30 | 20 | 44 | 7 | 51 | 96 | - | 147 | 680 | 827 | 206 | 205 | - | 205 | 273 |
| Iowa | 1 | 28 | 20 | 12 | 3 | 15 | 165 | - | 180 | 838 | 1,018 | 249 | 272 | - | 270 | 293 |
| Kansas | 5 | 25 | 18 | 71 | 21 | 92 | 75 | 20 | 187 | 1,012 | 1,199 | 301 | 124 | 330 | 233 | 288 |
| Kentucky | 3 | 33 | 11 | 111 | 11 | 122 | 228 | - | 350 | 128 | 478 | 288 | 231 | - | 251 | 256 |
| Louisiana | 6 | 29 | 16 | 183 | 158 | 341 | 61 | 513 | 915 | 812 | 1,727 | 275 | 290 | 363 | 325 | 256 |
| Maryland | 1 | 17 | 7 | 8 | 2 | 10 | 57 | - | 67 | 135 | 202 | 96 | 273 | - | 247 | 290 |
| Michigan | 3 | 51 | 17 | 143 | 49 | 192 | 102 | 27 | 321 | 1,227 | 1,548 | 270 | 274 | 277 | 272 | 263 |
| Minnesota | - | 9 | 5 | - | - | - | 12 | - | 12 | 213 | 225 | - | 189 | - | 189 | 273 |
| Mississippi | - | 40 | 24 | - | - | - | 153 | - | 153 | 807 | 960 | - | 163 | - | 163 | 276 |
| Missouri | - | 147 | 24 | - | - | - | 583 | - | 583 | 444 | 1,027 | - | 216 | - | 216 | 259 |
| Montana | 11 | 18 | 11 | 461 | 97 | 558 | 120 | - | 678 | 183 | 861 | 270 | 204 | - | 258 | 292 |
| Nebraska | - | 7 | 3 | - | - | - | 10 | - | 10 | 4 | 14 | - | 235 | - | 235 | 285 |
| Nevada | 9 | 42 | 15 | 19 | 1 | 20 | 178 | - | 198 | 572 | 770 | 157 | 243 | - | 234 | 290 |
| New Hampshire | - | 7 | - | - | - | - | 23 | - | 23 | - | 23 | - | 179 | - | 179 | 179 |
| New Jersey | - | 19 | 12 | - | - | - | 114 | 3 | 117 | 278 | 395 | - | 237 | 293 | 238 | 298 |
| New Mexico | 10 | 31 | 25 | 1,125 | 440 | 1,565 | 71 | - | 1,636 | 1,253 | 2,889 | 357 | 179 | - | 349 | 339 |
| New York | 11 | 26 | 29 | 500 | 115 | 615 | 174 | 64 | 853 | 1,522 | 2,375 | 272 | 208 | 348 | 264 | 255 |
| North Carolina | 5 | 86 | 35 | 83 | 24 | 107 | 373 | 2 | 482 | 1,265 | 1,747 | 252 | 221 | 130 | 227 | 243 |
| North Dakota | - | 6 | 2 | - | - | - | 16 | 3 | 19 | 23 | 42 | - | 39 | 365 | 90 | 322 |
| Ohio | 15 | 151 | 40 | 346 | 65 | 411 | 421 | 14 | 846 | 1,648 | 2,494 | 266 | 209 | 292 | 238 | 267 |
| Oklahoma | - | 28 | 6 | - | - | - | 193 | 5 | 198 | 181 | 379 | - | 226 | 282 | 227 | 227 |
| Oregon | - | 26 | 9 | - | - | - | 94 | 2 | 96 | 70 | 166 | - | 202 | 10 | 198 | 249 |
| Pennsylvania | 15 | 113 | 36 | 115 | 33 | 148 | 401 | 1 | 550 | 1,051 | 1,601 | 225 | 242 | 312 | 237 | 260 |
| South Carolina | - | 46 | 21 | - | - | - | 228 | - | 228 | 703 | 931 | - | 248 | - | 248 | 266 |
| South Dakota | - | 44 | 5 | - | - | - | 146 | - | 146 | 119 | 265 | - | 173 | - | 173 | 293 |
| Tennessee | - | 44 | 16 | - | - | - | 508 | - | 508 | 347 | 855 | - | 260 | - | 260 | 280 |
| Texas | 2 | 131 | 53 | 28 | 46 | 74 | 448 | 896 | 1,418 | 1,329 | 2,747 | 256 | 227 | 362 | 314 | 273 |
| Utah | 5 | 40 | 22 | 282 | 75 | 357 | 135 | 38 | 530 | 450 | 980 | 312 | 185 | 265 | 276 | 281 |
| Vermont | 3 | 3 | 6 | 34 | 4 | 38 | 74 | - | 112 | 209 | 321 | 298 | 244 | - | 262 | 282 |
| Virginia | 2 | 27 | 15 | 97 | 3 | 100 | 131 | 3 | 234 | 454 | 688 | 252 | 234 | 365 | 243 | 292 |
| Washington | - | 23 | 6 | - | - | - | 77 | 1 | 78 | 51 | 129 | - | 157 | 10 | 155 | 191 |
| West Virginia | 3 | 9 | 8 | 47 | 5 | 52 | 26 | 17 | 95 | 872 | 967 | 126 | 256 | 329 | 198 | 323 |
| Wyoming | 14 | 20 | 18 | 235 | 67 | 302 | 197 | 14 | 513 | 620 | 1,133 | 339 | 232 | 277 | 296 | 325 |
| Other States 1/ | 1 | 27 | 9 | 1 | - | 1 | 79 | 17 | 97 | 242 | 339 | 80 | 164 | 93 | 151 | 233 |
| Total or average | 202 | 1,965 | 845 | 4,493 | 1,335 | 5,828 | 9,568 | 1,818 | 17,214 | 31,215 | 48,429 | 294 | 238 | 341 | 268 | 283 |

1/ Includes Delaware, District of Columbia, Maine, Massachusetts, and Wisconsin.

TABLE A-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1965 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | 3,162 | 912 | 4,074 | 23,662 | 1,300 | 29,036 | 232,354 | 261,390 | 25,304 | 7,297 | 32,601 | 193,828 | 10,400 | 236,829 | 1,858,845 | 2,095,674 |
| Arizona | 9,728 | 2,513 | 12,241 | 24,692 | - | 36,933 | 29,200 | 66,133 | 77,821 | 20,104 | 97,925 | 198,131 | - | 296,056 | 234,223 | 530,279 |
| Arkansas | 15,900 | 2,262 | 18,162 | 21,124 | 2,114 | 41,400 | 128,443 | 169,843 | 127,195 | 18,099 | 145,294 | 171,347 | 16,915 | 333,556 | 1,038,151 | 1,371,707 |
| California | 25,166 | 3,472 | 28,638 | 168,840 | 33,715 | 231,193 | 1,115,703 | 1,346,896 | 201,325 | 26,712 | 228,037 | 1,369,471 | 274,839 | 1,872,347 | 9,031,780 | 10,904,127 |
| Colorado | 20,472 | 4,806 | 25,278 | 18,637 | 32 | 43,947 | 49,267 | 93,214 | 163,786 | 38,446 | 202,232 | 150,349 | 256 | 352,837 | 398,998 | 751,835 |
| Connecticut | - | - | - | 18,297 | - | 18,297 | 11,593 | 29,890 | - | - | - | 147,163 | - | 147,163 | 92,745 | 239,908 |
| Florida | - | - | - | 425,346 | 6,137 | 431,483 | 682,957 | 1,114,440 | - | - | - | 3,432,871 | 49,596 | 3,482,467 | 5,475,018 | 8,957,485 |
| Georgia | 3,285 | 1,010 | 4,295 | 196,479 | - | 200,774 | 730,271 | 931,045 | 32,850 | 10,100 | 42,950 | 1,588,288 | - | 1,631,238 | 5,861,146 | 7,492,384 |
| Hawaii | - | - | - | 5,720 | 300 | 6,020 | 3,116 | 9,136 | - | - | - | 43,671 | 1,200 | 44,871 | 24,931 | 69,802 |
| Idaho | - | - | - | 68,641 | - | 68,641 | 103,527 | 172,168 | - | - | - | 559,367 | - | 559,367 | 828,207 | 1,387,574 |
| Illinois | 56,792 | 14,074 | 70,866 | 19,392 | - | 90,258 | 258,330 | 348,588 | 455,117 | 112,611 | 567,728 | 155,164 | - | 722,892 | 2,095,190 | 2,818,082 |
| Indiana | 8,969 | 1,516 | 10,485 | 19,659 | - | 30,144 | 185,867 | 216,011 | 71,499 | 12,128 | 83,627 | 145,180 | - | 228,807 | 1,499,616 | 1,728,423 |
| Iowa | 2,984 | 750 | 3,734 | 44,869 | - | 48,603 | 245,660 | 294,263 | 23,870 | 6,000 | 29,870 | 364,370 | - | 394,240 | 1,984,626 | 2,378,866 |
| Kansas | 21,388 | 6,312 | 27,700 | 9,323 | 6,601 | 43,624 | 291,721 | 335,345 | 171,108 | 50,496 | 221,604 | 76,236 | 52,808 | 350,648 | 2,334,651 | 2,685,299 |
| Kentucky | 32,035 | 3,123 | 35,158 | 52,764 | - | 87,922 | 32,731 | 120,653 | 256,283 | 24,984 | 281,267 | 422,534 | - | 703,801 | 263,648 | 967,449 |
| Louisiana | 50,560 | 43,142 | 93,702 | 17,682 | 185,976 | 297,360 | 207,512 | 504,872 | 412,476 | 346,619 | 759,095 | 150,180 | 1,979,062 | 2,888,337 | 1,674,281 | 4,562,618 |
| Maryland | 768 | 192 | 960 | 15,556 | - | 16,516 | 39,155 | 55,671 | 6,145 | 1,536 | 7,681 | 125,169 | - | 132,850 | 305,628 | 438,478 |
| Michigan | 38,808 | 12,959 | 51,767 | 27,940 | 7,492 | 87,199 | 322,560 | 409,759 | 328,695 | 104,440 | 433,135 | 230,150 | 59,942 | 723,227 | 2,586,897 | 3,310,124 |
| Minnesota | - | - | - | 2,268 | - | 2,268 | 58,214 | 60,482 | - | - | - | 18,137 | - | 18,137 | 465,718 | 483,855 |
| Mississippi | - | - | - | 24,918 | - | 24,918 | 222,419 | 247,337 | - | - | - | 204,175 | - | 204,175 | 1,802,427 | 2,006,602 |
| Missouri | - | - | - | 126,006 | - | 126,006 | 114,994 | 241,000 | - | - | - | 1,023,400 | - | 1,023,400 | 933,635 | 1,957,035 |
| Montana | 124,306 | 26,266 | 150,572 | 24,424 | - | 174,996 | 53,517 | 228,513 | 994,241 | 209,404 | 1,203,645 | 196,911 | - | 1,400,556 | 427,970 | 1,828,526 |
| Nebraska | - | - | - | 2,349 | - | 2,349 | 1,140 | 3,489 | - | - | - | 18,800 | - | 18,800 | 9,120 | 27,920 |
| Nevada | 2,831 | 300 | 3,131 | 43,280 | - | 46,411 | 165,909 | 212,320 | 22,348 | 2,400 | 24,748 | 356,495 | - | 381,243 | 1,327,726 | 1,708,969 |
| New Hampshire | - | - | - | 4,128 | - | 4,128 | - | 4,128 | - | - | - | 32,629 | - | 32,629 | - | 32,629 |
| New Jersey | - | - | - | 26,993 | 880 | 27,873 | 82,906 | 110,779 | - | - | - | 215,920 | 7,042 | 222,962 | 663,331 | 886,293 |
| New Mexico | 401,299 | 157,780 | 559,079 | 12,700 | - | 571,779 | 424,979 | 996,758 | 3,210,352 | 1,262,274 | 4,472,626 | 101,425 | - | 4,574,051 | 3,399,847 | 7,973,898 |
| New York | 135,741 | 31,355 | 167,096 | 36,185 | 22,241 | 225,522 | 388,382 | 613,904 | 1,147,065 | 263,026 | 1,410,091 | 288,769 | 177,932 | 1,876,792 | 3,141,997 | 5,018,789 |
| North Carolina | 21,120 | 5,868 | 26,988 | 82,288 | 260 | 109,536 | 306,763 | 416,299 | 168,957 | 46,944 | 215,901 | 662,180 | 2,080 | 880,161 | 2,416,235 | 3,296,396 |
| North Dakota | - | - | - | 623 | 1,095 | 1,718 | 7,409 | 9,127 | - | - | - | 5,041 | 8,760 | 13,801 | 59,270 | 73,071 |
| Ohio | 91,737 | 17,464 | 109,201 | 88,105 | 4,089 | 201,395 | 440,673 | 642,068 | 736,265 | 139,709 | 875,974 | 712,318 | 32,709 | 1,621,001 | 3,533,128 | 5,154,129 |
| Oklahoma | - | - | - | 43,634 | 1,410 | 45,044 | 41,016 | 86,060 | - | - | - | 347,532 | 12,178 | 359,710 | 329,431 | 689,141 |
| Oregon | - | - | - | 18,947 | 20 | 18,967 | 17,431 | 36,398 | - | - | - | 151,713 | 160 | 151,873 | 139,456 | 291,329 |
| Pennsylvania | 25,986 | 7,246 | 33,232 | 96,930 | 312 | 130,474 | 273,413 | 403,887 | 204,997 | 56,685 | 261,682 | 816,118 | 2,616 | 1,080,416 | 2,228,112 | 3,308,528 |
| South Carolina | - | - | - | 56,439 | - | 56,439 | 187,013 | 243,452 | - | - | - | 469,186 | - | 469,186 | 1,506,371 | 1,975,557 |
| South Dakota | - | - | - | 25,288 | - | 25,288 | 34,839 | 60,127 | - | - | - | 209,523 | - | 209,523 | 278,711 | 488,234 |
| Tennessee | - | - | - | 132,284 | - | 132,284 | 97,181 | 229,465 | - | - | - | 1,089,737 | - | 1,089,737 | 787,127 | 1,876,864 |
| Texas | 6,997 | 11,945 | 18,942 | 101,770 | 324,128 | 444,840 | 363,445 | 808,285 | 55,978 | 95,560 | 151,538 | 813,719 | 2,593,695 | 3,558,952 | 2,976,142 | 6,535,094 |
| Utah | 85,041 | 26,188 | 111,229 | 24,998 | 10,084 | 146,311 | 126,632 | 272,943 | 680,335 | 209,508 | 889,843 | 200,252 | 80,677 | 1,170,772 | 1,013,026 | 2,183,798 |
| Vermont | 10,218 | 1,112 | 11,330 | 18,035 | - | 29,365 | 58,880 | 88,245 | 82,987 | 9,148 | 92,135 | 142,478 | - | 234,613 | 477,284 | 711,897 |
| Virginia | 24,442 | 762 | 25,204 | 30,669 | 1,095 | 56,968 | 132,581 | 189,549 | 195,545 | 6,096 | 201,641 | 252,864 | 8,760 | 463,265 | 1,067,288 | 1,530,553 |
| Washington | - | - | - | 12,085 | 10 | 12,095 | 9,758 | 21,853 | - | - | - | 97,131 | 80 | 97,211 | 78,066 | 175,277 |
| West Virginia | 5,332 | 1,222 | 6,554 | 6,661 | 5,588 | 18,803 | 281,245 | 300,048 | 42,656 | 9,776 | 52,432 | 53,290 | 44,064 | 149,786 | 2,249,964 | 2,399,750 |
| Wyoming | 79,233 | 23,113 | 102,346 | 45,655 | 3,878 | 151,879 | 201,710 | 353,589 | 633,862 | 182,742 | 816,604 | 388,155 | 31,605 | 1,236,364 | 1,623,417 | 2,859,781 |
| Other States 1/ | 80 | - | 80 | 12,985 | 1,575 | 14,640 | 56,416 | 71,056 | 640 | - | 640 | 106,227 | 12,600 | 119,467 | 451,540 | 571,007 |
| Total | 1,304,380 | 407,664 | 1,712,044 | 2,279,270 | 620,332 | 4,611,646 | 8,818,832 | 13,430,478 | 10,529,702 | 3,272,844 | 13,802,546 | 18,497,594 | 5,459,976 | 37,760,116 | 70,974,920 | 108,735,036 |

1/ Includes Delaware, District of Columbia, Maine, Massachusetts, and Wisconsin.

TABLE A-22. - Injury experience and employment data on officeworkers at nonmetal mines and mills in the United States, by mineral industry, 1965

| Mineral industry | Injuries | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | | | | |
| Clay | - | 3 | 3 | - | 1.17 | 1.17 | - | 9 | 9 | 1,236 | 261 | 322,099 | 2,563,910 |
| Gypsum | - | - | - | - | - | - | - | - | - | 405 | 260 | 105,188 | 840,051 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | 429 | 249 | 106,958 | 856,942 |
| Potash | - | - | - | - | - | - | - | - | - | 171 | 291 | 49,801 | 398,872 |
| Salt | - | 1 | 1 | - | .51 | .51 | - | 2 | 2 | 938 | 264 | 247,704 | 1,974,293 |
| Sulfur | - | - | - | - | - | - | - | - | - | 21 | 313 | 6,579 | 52,632 |
| Miscellaneous nonmetals 1/ | - | 2 | 2 | - | .80 | .80 | - | 57 | 57 | 1,159 | 269 | 311,907 | 2,486,598 |
| Total or average | - | 6 | 6 | - | .65 | .65 | - | 19 | 19 | 4,359 | 264 | 1,150,236 | 9,173,298 |

1/ Includes abrasives, asbestos, aplite, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite and wollastonite.

TABLE A-23. - Injury experience and employment data on officeworkers at nonmetal mines and mills in the United States, by State, 1965

| State | Injuries | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | 42 | 264 | 11,093 | 91,538 |
| Arizona | - | - | - | - | - | - | - | - | - | 23 | 234 | 5,380 | 43,252 |
| Arkansas | - | - | - | - | - | - | - | - | - | 59 | 275 | 16,214 | 128,065 |
| California | - | - | - | - | - | - | - | - | - | 550 | 261 | 143,748 | 1,149,445 |
| Colorado | - | - | - | - | - | - | - | - | - | 26 | 187 | 4,867 | 36,716 |
| Connecticut | - | - | - | - | - | - | - | - | - | 6 | 228 | 1,367 | 9,940 |
| District of Columbia | - | - | - | - | - | - | - | - | - | 3 | 260 | 780 | 6,240 |
| Florida | - | - | - | - | - | - | - | - | - | 348 | 265 | 92,167 | 737,839 |
| Georgia | - | 1 | 1 | - | 1.68 | 1.68 | - | 12 | 12 | 286 | 261 | 74,621 | 594,953 |
| Hawaii | - | - | - | - | - | - | - | - | - | 3 | 206 | 619 | 4,955 |
| Idaho | - | - | - | - | - | - | - | - | - | 47 | 183 | 8,606 | 69,545 |
| Illinois | - | - | - | - | - | - | - | - | - | 113 | 288 | 32,513 | 265,788 |
| Indiana | - | - | - | - | - | - | - | - | - | 87 | 256 | 22,259 | 177,097 |
| Iowa | - | - | - | - | - | - | - | - | - | 101 | 268 | 27,116 | 217,958 |
| Kansas | - | - | - | - | - | - | - | - | - | 126 | 249 | 31,382 | 247,568 |
| Kentucky | - | - | - | - | - | - | - | - | - | 27 | 262 | 7,084 | 54,959 |
| Louisiana | - | 1 | 1 | - | 5.12 | 5.12 | - | 20 | 20 | 94 | 257 | 24,170 | 195,298 |
| Maine | - | - | - | - | - | - | - | - | - | 6 | 259 | 1,554 | 12,432 |
| Maryland | - | - | - | - | - | - | - | - | - | 11 | 260 | 2,860 | 22,880 |
| Massachusetts | - | - | - | - | - | - | - | - | - | 5 | 260 | 1,300 | 10,400 |
| Michigan | - | - | - | - | - | - | - | - | - | 318 | 256 | 81,440 | 646,819 |
| Minnesota | - | - | - | - | - | - | - | - | - | 20 | 241 | 4,824 | 38,990 |
| Mississippi | - | - | - | - | - | - | - | - | - | 51 | 281 | 14,314 | 115,096 |
| Missouri | - | - | - | - | - | - | - | - | - | 42 | 249 | 10,437 | 83,491 |
| Montana | - | - | - | - | - | - | - | - | - | 43 | 262 | 11,275 | 90,156 |
| Nebraska | - | - | - | - | - | - | - | - | - | 4 | 300 | 1,200 | 9,600 |
| Nevada | - | - | - | - | - | - | - | - | - | 111 | 271 | 30,085 | 239,284 |
| New Jersey | - | - | - | - | - | - | - | - | - | 45 | 247 | 11,130 | 87,873 |
| New Mexico | - | - | - | - | - | - | - | - | - | 165 | 283 | 46,771 | 373,755 |
| New York | - | - | - | - | - | - | - | - | - | 221 | 269 | 59,389 | 473,794 |
| North Carolina | - | - | - | - | - | - | - | - | - | 127 | 244 | 30,992 | 246,062 |
| North Dakota | - | - | - | - | - | - | - | - | - | 4 | 205 | 821 | 6,570 |
| Ohio | - | - | - | - | - | - | - | - | - | 207 | 267 | 55,240 | 432,384 |
| Oklahoma | - | - | - | - | - | - | - | - | - | 21 | 233 | 4,887 | 37,912 |
| Oregon | - | - | - | - | - | - | - | - | - | 12 | 248 | 2,975 | 21,550 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | 90 | 262 | 23,588 | 183,898 |
| South Carolina | - | 1 | 1 | - | 9.68 | 9.68 | - | 29 | 29 | 50 | 258 | 12,909 | 103,272 |
| South Dakota | - | - | - | - | - | - | - | - | - | 13 | 280 | 3,642 | 29,134 |
| Tennessee | - | - | - | - | - | - | - | - | - | 38 | 272 | 10,327 | 82,886 |
| Texas | - | 1 | 1 | - | 3.08 | 3.08 | - | 43 | 43 | 153 | 265 | 40,587 | 324,817 |
| Utah | - | - | - | - | - | - | - | - | - | 75 | 270 | 20,264 | 161,605 |
| Vermont | - | - | - | - | - | - | - | - | - | 23 | 259 | 5,947 | 47,288 |
| Virginia | - | - | - | - | - | - | - | - | - | 50 | 275 | 13,736 | 109,595 |
| Washington | - | 1 | 1 | - | 33.07 | 33.07 | - | 463 | 463 | 15 | 258 | 3,874 | 30,242 |
| West Virginia | - | - | - | - | - | - | - | - | - | 380 | 270 | 102,431 | 819,452 |
| Wyoming | - | 1 | 1 | - | 3.32 | 3.32 | - | 425 | 425 | 118 | 317 | 37,451 | 300,905 |
| Total or average | - | 6 | 6 | - | .65 | .65 | - | 19 | 19 | 4,359 | 264 | 1,150,236 | 9,173,298 |

APPENDIX B.-STATISTICAL TABLES FOR THE NONMETALLIC INDUSTRY, 1964

TABLE B-1.- Injury experience by degree and employment data on nonmetal mines and mills in the United States, by general work location, 1964

| General work location | Injuries | | | | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Active operations | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Fatal | Non-fatal | All injuries | Fatal | Non-fatal | All injuries | | | | | |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | | | | |
| Underground mines: | | | | | | | | | | | | | | | | | |
| Underground | 7 | - | 12 | 438 | 450 | 457 | 0.71 | 45.49 | 46.20 | 4,245 | 2,000 | 6,246 | 213 | 4,433 | 277 | 1,226,280 | 9,892,832 |
| Surface | 1 | - | 4 | 66 | 70 | 71 | .26 | 18.39 | 18.65 | 1,576 | 1,439 | 3,015 | - | 1,603 | 295 | 473,341 | 3,806,633 |
| Total or average | 8 | - | 16 | 504 | 520 | 528 | .58 | 37.96 | 38.54 | 3,504 | 1,844 | 5,348 | 213 | 6,036 | 282 | 1,699,621 | 13,699,465 |
| Open pit mines | 10 | 1 | 4 | 300 | 305 | 315 | .60 | 18.43 | 19.04 | 3,626 | 1,145 | 4,772 | 1,815 | 8,939 | 228 | 2,041,992 | 16,546,196 |
| Other surface mining | - | - | 2 | 79 | 81 | 81 | - | 14.13 | 14.13 | - | 992 | 992 | 162 | 2,112 | 321 | 678,370 | 5,731,084 |
| Total or average, mining | 18 | 1 | 22 | 883 | 906 | 924 | .50 | 25.18 | 25.68 | 3,002 | 1,387 | 4,389 | 2,190 | 17,087 | 259 | 4,419,983 | 35,976,745 |
| Mills | 6 | 3 | 38 | 1,539 | 1,580 | 1,586 | .08 | 22.11 | 22.19 | 504 | 1,046 | 1,550 | 911 | 31,967 | 279 | 8,913,774 | 71,461,124 |
| Grand total or average | 24 | 4 | 60 | 2,422 | 2,486 | 2,510 | .22 | 23.14 | 23.36 | 1,340 | 1,160 | 2,501 | 3,101 | 49,054 | 272 | 13,333,757 | 107,437,869 |

TABLE B-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964

| General work location and detailed cause | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| UNDERGROUND MINES | | | | | | | | | |
| Underground: | | | | | | | | | |
| Falls of roof or back: | | | | | | | | | |
| While mining | - | - | - | 16 | 16 | 16 | - | 24 | 24 |
| While loading | - | - | - | 2 | 2 | 2 | - | 4 | 4 |
| While testing or barring down back | 1 | - | - | 4 | 4 | 5 | - | 5 | 1,204 |
| While setting or removing timber or other support | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| While preparing or installing rock bolt | - | - | - | 1 | 1 | 1 | - | 139 | 139 |
| All other | - | - | - | 11 | 11 | 11 | - | 19 | 19 |
| Falls of face or side: | | | | | | | | | |
| While mining | - | - | 1 | 6 | 7 | 7 | 900 | 48 | 169 |
| While loading | - | - | - | 1 | 1 | 1 | - | 247 | 247 |
| While testing or barring down back | - | - | - | 4 | 4 | 4 | - | 32 | 32 |
| While moving machinery | - | - | - | 1 | 1 | 1 | - | 218 | 218 |
| All other | - | - | - | 15 | 15 | 15 | - | 15 | 15 |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Dropped or thrown by coworker | - | - | - | 2 | 2 | 2 | - | 5 | 5 |
| From car, bin, platform, or chute | - | - | - | 4 | 4 | 4 | - | 17 | 17 |
| Falling equipment or machinery under repair | 1 | - | - | - | - | 1 | - | - | 6,000 |
| From stockpile, dump, or gob | - | - | 1 | 9 | 10 | 10 | 150 | 25 | 38 |
| All other | - | - | - | 7 | 7 | 7 | - | 24 | 24 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While escaping another hazard | - | - | - | 2 | 2 | 2 | - | 30 | 30 |
| While handling material | - | - | - | 11 | 11 | 11 | - | 30 | 30 |
| Caused by handtool slipping or breaking | - | - | - | 1 | 1 | 1 | - | 79 | 79 |
| While operating or moving machinery | - | - | - | 3 | 3 | 3 | - | 23 | 23 |
| All other | - | - | - | 13 | 13 | 13 | - | 10 | 10 |
| From an elevation: | | | | | | | | | |
| While handling material | - | - | - | 3 | 3 | 3 | - | 12 | 12 |
| While operating or moving machinery | - | - | - | 2 | 2 | 2 | - | 5 | 5 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 1 | 1 | 1 | - | 28 | 28 |
| All other | - | - | - | 3 | 3 | 3 | - | 5 | 5 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | 1 | 13 | 14 | 14 | 50 | 16 | 18 |
| Ore, valuable mineral | - | - | - | 6 | 6 | 6 | - | 24 | 24 |
| Rock or waste | - | - | - | 3 | 3 | 3 | - | 93 | 93 |
| Rail | - | - | 1 | 4 | 5 | 5 | 50 | 14 | 21 |
| Wire or wire rope | - | - | 1 | 17 | 18 | 18 | 200 | 12 | 22 |
| Conveyor pan | - | - | - | 4 | 4 | 4 | - | 15 | 15 |
| All other | - | - | - | 52 | 52 | 52 | - | 16 | 16 |
| Handtools: | | | | | | | | | |
| Axe, hatchet, or adz | - | - | - | 4 | 4 | 4 | - | 14 | 14 |
| Hammer or sledge | - | - | - | 2 | 2 | 2 | - | 8 | 8 |
| Crowbar or bar | - | - | - | 4 | 4 | 4 | - | 5 | 5 |
| Shovel | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| Handtool used to install rock bolt | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Flying particle from tool or object worked on | - | - | - | 6 | 6 | 6 | - | 8 | 8 |
| All other | - | - | - | 14 | 14 | 14 | - | 10 | 10 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | |
| Stepping on sharp object | - | - | - | 4 | 4 | 4 | - | 3 | 3 |
| Stepping on loose object | - | - | - | 8 | 8 | 8 | - | 20 | 20 |
| Striking or bumping against objects | - | - | - | 3 | 3 | 3 | - | 4 | 4 |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | |
| Coupling or uncoupling | - | - | 1 | 4 | 5 | 5 | 75 | 13 | 26 |
| Switching, spragging, blocking, or braking | - | - | - | 1 | 1 | 1 | - | 18 | 18 |
| Operating or riding | - | - | - | 2 | 2 | 2 | - | 12 | 12 |
| All other | - | - | - | 3 | 3 | 3 | - | 14 | 14 |
| Squeezed between cage, car or motor, and other object: | | | | | | | | | |
| Coupling or uncoupling | - | - | - | 1 | 1 | 1 | - | 37 | 37 |
| Pulling, pushing, or dropping | - | - | - | 3 | 3 | 3 | - | 53 | 53 |
| Operating or riding | - | - | - | 2 | 2 | 2 | - | 7 | 7 |
| All other | - | - | - | 3 | 3 | 3 | - | 34 | 34 |
| Derailment | - | - | 1 | 2 | 3 | 3 | 3,000 | 7 | 1,004 |
| Rerailing | - | - | 1 | 3 | 4 | 4 | 300 | 5 | 79 |
| Collision (while under control) | - | - | - | 7 | 7 | 7 | - | 29 | 29 |
| Runaway (while not under control) | - | - | - | 2 | 2 | 2 | - | 18 | 18 |
| Falling, slipping, or jumping into or from | 1 | - | - | 6 | 6 | 7 | - | 42 | 893 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Struck or run over | - | - | 1 | 1 | 2 | 2 | 3,000 | 12 | 1,506 |
| All other | - | - | - | 5 | 5 | 5 | - | 4 | 4 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 3 | 3 | 3 | - | 11 | 11 |
| All other | 1 | - | - | 5 | 5 | 6 | - | 42 | 1,035 |
| Miscellaneous haulage: | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | - | - | - | 3 | 3 | 3 | - | 8 | 8 |
| Rope or cable on haulage | - | - | - | 3 | 3 | 3 | - | 79 | 79 |
| Animal on haulage | - | - | - | 1 | 1 | 1 | - | 48 | 48 |
| Slip or strain from moving car by hand | - | - | - | 6 | 6 | 6 | - | 33 | 33 |
| Riding or getting on or off conveyor belt | - | - | - | 2 | 2 | 2 | - | 69 | 69 |
| Flying particle | - | - | - | 4 | 4 | 4 | - | 13 | 13 |
| All other | - | - | - | 6 | 6 | 6 | - | 44 | 44 |
| Explosives: | | | | | | | | | |
| Misfire or digging into unexploded hole | - | - | - | 2 | 2 | 2 | - | 89 | 89 |
| Flying fragments | - | - | - | 2 | 2 | 2 | - | 27 | 27 |
| Insufficient warning, short fuse, or short cable | - | - | - | 2 | 2 | 2 | - | 7 | 7 |
| Electricity: | | | | | | | | | |
| Trolley wire or pole | 1 | - | - | 1 | 1 | 2 | - | 9 | 3,005 |
| Locomotive or shuttle car | 1 | - | - | 2 | 2 | 3 | - | 6 | 2,004 |

TABLE B-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| UNDERGROUND MINES - Continued | | | | | | | | | |
| Underground - Continued | | | | | | | | | |
| Electricity - Continued | | | | | | | | | |
| Mining or loading machine | - | - | - | 1 | 1 | 1 | - | 53 | 53 |
| Cut-out switch or junction box | - | - | - | 2 | 2 | 2 | - | 2 | 2 |
| Cable, cable arc, or blowup | - | - | - | 5 | 5 | 5 | - | 11 | 11 |
| Machinery: | | | | | | | | | |
| While moving machine (chain, arc, longwall) | - | - | - | 2 | 2 | 2 | - | 12 | 12 |
| While setting up (jack, bar, skid) | - | - | - | 1 | 1 | 1 | - | 11 | 11 |
| While operating (cutter bar, chain, bit) | - | - | - | 1 | 1 | 1 | - | 12 | 12 |
| Belt conveyor | - | - | - | 2 | 2 | 2 | - | 10 | 10 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | 1 | 2 | 2 | 49 | 2 | 26 |
| Loading machines (including self-loading heads) | - | - | - | 7 | 7 | 7 | - | 39 | 39 |
| While moving loading machines or self-loading heads | - | - | - | 2 | 2 | 2 | - | 21 | 21 |
| Mucking machine, mechanical loader | - | - | 1 | 4 | 5 | 5 | 200 | 29 | 63 |
| Power drill; rotary or percussive (except rock bolting) | - | - | - | 14 | 14 | 14 | - | 20 | 20 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | 4 | 4 | 4 | - | 46 | 46 |
| Stationary machinery | - | - | 1 | - | 1 | 1 | 2,400 | - | 2,400 |
| While moving machine (except chain, arc, longwall) | - | - | - | 4 | 4 | 4 | - | 20 | 20 |
| Particle set in motion by machinery (except rock bolting) | - | - | - | 7 | 7 | 7 | - | 5 | 5 |
| Continuous mining machine | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| All other | - | - | - | 3 | 3 | 3 | - | 30 | 30 |
| Suffocation (no flame or smoldering): | | | | | | | | | |
| Natural mine gas or oxygen deficient | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Foreign gas | - | - | - | 4 | 4 | 4 | - | 45 | 45 |
| Miscellaneous causes: | | | | | | | | | |
| Flying particle from draft or wind | - | - | - | 2 | 2 | 2 | - | 10 | 10 |
| Irritation or burn from caustic or acid | - | - | - | 4 | 4 | 4 | - | 5 | 5 |
| Burn from controlled fire | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| All other | - | - | - | 8 | 8 | 8 | - | 12 | 12 |
| Total or average | 6 | - | 12 | 438 | 450 | 456 | 865 | 21 | 124 |
| Shaft and slope: | | | | | | | | | |
| Slips or falls of persons: Down shaft or slope | 1 | - | - | - | - | 1 | - | - | 6,000 |
| Total or average | 1 | - | - | - | - | 1 | - | - | 6,000 |
| Total or average, underground | 7 | - | 12 | 438 | 450 | 457 | 865 | 21 | 135 |
| Surface: | | | | | | | | | |
| Sliding or falling material or objects | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | - | 6 | 6 | 6 | - | 16 | 16 |
| All other | - | - | - | 2 | 2 | 2 | - | 2 | 2 |
| From an elevation: | | | | | | | | | |
| While handling material | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| While operating or moving machinery | - | - | - | 1 | 1 | 1 | - | 43 | 43 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 1 | 1 | 1 | - | 64 | 64 |
| All other | - | - | - | 1 | 1 | 1 | - | 51 | 51 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 2 | 2 | 2 | - | 24 | 24 |
| Ore, valuable mineral | - | - | - | 1 | 1 | 1 | - | 12 | 12 |
| Rail | - | - | - | 1 | 1 | 1 | - | 41 | 41 |
| Wire or wire rope | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| All other | - | - | 1 | 15 | 16 | 16 | 75 | 70 | 71 |
| Handtools: | | | | | | | | | |
| Hammer or sledge | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Crowbar or bar | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| In hand of fellow worker | - | - | - | 1 | 1 | 1 | - | 5 | 5 |
| Flying particle from tool or object worked on | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| All other | - | - | - | 2 | 2 | 2 | - | 10 | 10 |
| Stepping or kneeling on sharp or loose object: Stepping on loose object | - | - | - | 2 | 2 | 2 | - | 15 | 15 |
| Haulage: | | | | | | | | | |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Unspecified | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Railroad cars and locomotives | 1 | - | - | 5 | 5 | 6 | - | 24 | 1,020 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 3 | 3 | 3 | - | 44 | 44 |
| All other | - | - | - | 1 | 1 | 1 | - | 66 | 66 |
| Water transportation: Rope or chain on boat or barge | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| Miscellaneous haulage: Slip or strain from moving car by hand | - | - | - | 1 | 1 | 1 | - | 45 | 45 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | - | 1 | 1 | 1 | - | 11 | 11 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | 1 | 2 | 2 | 1,250 | 3 | 627 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | 3 | 3 | 3 | - | 24 | 24 |
| Stationary machinery | - | - | 2 | 1 | 3 | 3 | 1,020 | 15 | 685 |
| While moving any machine (except chain, arc, longwall) | - | - | - | 2 | 2 | 2 | - | 45 | 45 |
| Particle set in motion by machinery (except rock bolting) | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Miscellaneous causes: | | | | | | | | | |
| Acetylene or electric welding or cutting | - | - | - | 3 | 3 | 3 | - | 15 | 15 |
| All other | - | - | - | 1 | 1 | 1 | - | 28 | 28 |
| Total or average | 1 | - | 4 | 66 | 70 | 71 | 841 | 32 | 162 |
| Total or average, underground mines | 8 | - | 16 | 504 | 520 | 528 | 859 | 23 | 139 |

TABLE B-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| OPEN PIT MINES | | | | | | | | | |
| Falls of face or side: | | | | | | | | | |
| While mining | 2 | - | - | 1 | 1 | 3 | - | 15 | 4,005 |
| While loading | - | - | - | 1 | 1 | 1 | - | 42 | 42 |
| All other | - | - | - | 2 | 2 | 2 | - | 11 | 11 |
| Sliding or falling material or objects: | | | | | | | | | |
| Dropped or thrown by coworker | - | - | - | 2 | 2 | 2 | - | 11 | 11 |
| From car, bin, platform, or chute | - | - | - | 9 | 9 | 9 | - | 32 | 32 |
| From stockpile, dump, or gob | - | - | - | 1 | 1 | 1 | - | 14 | 14 |
| All other | - | - | - | 4 | 4 | 4 | - | 31 | 31 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While escaping another hazard | - | - | - | 3 | 3 | 3 | - | 22 | 22 |
| While handling material | - | - | - | 16 | 16 | 16 | - | 25 | 25 |
| Caused by handtool slipping or breaking | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| While operating or moving machinery | - | - | - | 2 | 2 | 2 | - | 6 | 6 |
| All other | - | - | - | 11 | 11 | 11 | - | 16 | 16 |
| From an elevation: | | | | | | | | | |
| While handling material | - | - | - | 7 | 7 | 7 | - | 48 | 48 |
| While operating or moving machinery | - | - | - | 10 | 10 | 10 | - | 53 | 53 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 2 | 2 | 2 | - | 15 | 15 |
| All other | - | - | - | 6 | 6 | 6 | - | 59 | 59 |
| Handling materials: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 6 | 6 | 6 | - | 57 | 57 |
| Rock or waste | - | - | - | 4 | 4 | 4 | - | 12 | 12 |
| Rail | - | - | - | 4 | 4 | 4 | - | 53 | 53 |
| Flying particle while handling material | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| All other | 1 | - | 1 | 75 | 76 | 77 | 220 | 18 | 99 |
| Handtools: | | | | | | | | | |
| Hammer or sledge | - | - | - | 5 | 5 | 5 | - | 28 | 28 |
| Crowbar or bar | - | - | - | 5 | 5 | 5 | - | 16 | 16 |
| In hand of fellow worker | - | - | - | 1 | 1 | 1 | - | 30 | 30 |
| Flying particle from tool or object worked on | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| All other | - | - | - | 6 | 6 | 6 | - | 13 | 13 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | |
| Stepping on sharp object | - | - | - | 2 | 2 | 2 | - | 9 | 9 |
| Stepping on loose object | - | - | - | 13 | 13 | 13 | - | 15 | 15 |
| Striking or bumping against objects | - | - | - | 2 | 2 | 2 | - | 7 | 7 |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Rerailing | - | - | - | 1 | 1 | 1 | - | 8 | 8 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Struck or run over | - | - | - | 1 | 1 | 1 | - | 56 | 56 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | - | 1 | 1 | 1 | - | 152 | 152 |
| Railroad cars and locomotives | - | - | - | 9 | 9 | 9 | - | 59 | 59 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 12 | 12 | 12 | - | 55 | 55 |
| All other | 5 | 1 | - | 17 | 18 | 23 | - | 50 | 1,602 |
| Miscellaneous haulage: | | | | | | | | | |
| Rope or cable on haulage | - | - | - | 1 | 1 | 1 | - | 10 | 10 |
| Slip or strain from moving car by hand | - | - | - | 1 | 1 | 1 | - | 15 | 15 |
| Flying particle | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| Electricity: | | | | | | | | | |
| Power or lighting circuit | - | - | 1 | 1 | 2 | 2 | 1,200 | 5 | 603 |
| All other | - | - | - | 1 | 1 | 1 | - | 28 | 28 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | - | 5 | 5 | 5 | - | 45 | 45 |
| While moving loading machines or self-loading heads | - | - | - | 1 | 1 | 1 | - | 58 | 58 |
| Mucking machine, mechanical loader | - | - | - | 3 | 3 | 3 | - | 37 | 37 |
| Power drill; rotary or percussive (except rock bolting) | - | - | - | 4 | 4 | 4 | - | 59 | 59 |
| Power shovel, dragline, bulldozer, etc. | 1 | - | 1 | 13 | 14 | 15 | 75 | 44 | 443 |
| Stationary machinery | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| While moving machine (except chain, arc, longwall) | - | - | 1 | 6 | 7 | 7 | 2,400 | 46 | 383 |
| Particle set in motion by machinery (except rock bolting) | - | - | - | 1 | 1 | 1 | - | 7 | 7 |
| All other | 1 | - | - | 5 | 5 | 6 | - | 28 | 1,023 |
| Miscellaneous causes: | | | | | | | | | |
| Flying particle from draft or wind | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Acetylene or electric welding or cutting | - | - | - | 2 | 2 | 2 | - | 4 | 4 |
| Irritation or burn from caustic or acid | - | - | - | 1 | 1 | 1 | - | 6 | 6 |
| Burn from controlled fire | - | - | - | 2 | 2 | 2 | - | 7 | 7 |
| All other | - | - | - | 5 | 5 | 5 | - | 19 | 19 |
| Pneumoconiosis | - | - | - | 1 | 1 | 1 | - | 23 | 23 |
| Total or average | 10 | 1 | 4 | 300 | 305 | 315 | 974 | 30 | 251 |
| OTHER SURFACE MINING | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | |
| From car, bin, platform, or chute | - | - | - | 1 | 1 | 1 | - | 60 | 60 |
| All other | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While handling material | - | - | - | 1 | 1 | 1 | - | 30 | 30 |
| All other | - | - | - | 3 | 3 | 3 | - | 91 | 91 |
| From an elevation: | | | | | | | | | |
| Caused by handtool slipping or breaking | - | - | - | 1 | 1 | 1 | - | 68 | 68 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 3 | 3 | 3 | - | 76 | 76 |
| All other | - | - | - | 2 | 2 | 2 | - | 7 | 7 |

TABLE B-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries: Fatal | Injuries: Nonfatal: Permanent: Total | Injuries: Nonfatal: Permanent: Partial | Injuries: Nonfatal: Temporary total | Injuries: Nonfatal: Total nonfatal | Injuries: All injuries | Average severity: Permanent partial | Average severity: Temporary total | Average severity: All injuries |
|---|---|---|---|---|---|---|---|---|---|
| OTHER SURFACE MINING - Continued | | | | | | | | | |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 2 | 2 | 2 | - | 12 | 12 |
| Wire or wire rope | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| All other | - | - | - | 17 | 17 | 17 | - | 22 | 22 |
| Handtools: | | | | | | | | | |
| Pick | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Hammer or sledge | - | - | - | 2 | 2 | 2 | - | 13 | 13 |
| All other | - | - | - | 5 | 5 | 5 | - | 13 | 13 |
| Stepping or kneeling on sharp or loose objects: Stepping on sharp object | - | - | - | 1 | 1 | 1 | - | 12 | 12 |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between: Coupling or uncoupling | - | - | - | 1 | 1 | 1 | - | 5 | 5 |
| Rerailing | - | - | - | 1 | 1 | 1 | - | 51 | 51 |
| Shuttle cars, transloaders, and small mobile trucks: Struck or run over | - | - | - | 1 | 1 | 1 | - | 60 | 60 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 4 | 4 | 4 | - | 39 | 39 |
| All other | - | - | - | 5 | 5 | 5 | - | 28 | 28 |
| Miscellaneous haulage: | | | | | | | | | |
| Slip or strain from moving car by hand | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| All other | - | - | - | 1 | 1 | 1 | - | 2 | 2 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | - | 2 | 2 | 2 | - | 174 | 174 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | - | 1 | 1 | 3,000 | - | 3,000 |
| Power drill; rotary or percussive (except rock bolting) | - | - | - | 2 | 2 | 2 | - | 30 | 30 |
| Stationary machinery | - | - | 1 | 1 | 2 | 2 | 100 | 74 | 87 |
| While moving any machine (except chain, arc, longwall) | - | - | - | 1 | 1 | 1 | - | 55 | 55 |
| Particle set in motion by machinery (except rock bolting) | - | - | - | 2 | 2 | 2 | - | 18 | 18 |
| All other | - | - | - | 6 | 6 | 6 | - | 53 | 53 |
| Mine fires or suffocation from fires: Burning mineral or timber | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Miscellaneous causes: | | | | | | | | | |
| Acetylene or electric welding or cutting | - | - | - | 2 | 2 | 2 | - | 4 | 4 |
| Irritation or burn from caustic or acid | - | - | - | 4 | 4 | 4 | - | 6 | 6 |
| Burn from controlled fire | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| All other | - | - | - | 2 | 2 | 2 | - | 37 | 37 |
| Total or average | - | - | 2 | 79 | 81 | 81 | 1,550 | 33 | 70 |
| Total or average, mining | 18 | 1 | 22 | 883 | 906 | 924 | 942 | 26 | 171 |
| MILLS | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | |
| Timber or other support | - | - | - | 2 | 2 | 2 | - | 20 | 20 |
| Dropped or thrown by coworker | - | - | - | 8 | 8 | 8 | - | 12 | 12 |
| From car, bin, platform, or chute | - | - | - | 28 | 28 | 28 | - | 19 | 19 |
| Falling cage | - | - | - | 1 | 1 | 1 | - | 7 | 7 |
| Falling equipment or machinery under repair | - | - | - | 4 | 4 | 4 | - | 28 | 28 |
| From stockpile, dump, or gob | - | - | - | 1 | 1 | 1 | - | 36 | 36 |
| All other | - | - | - | 13 | 13 | 13 | - | 11 | 11 |
| Slips or falls of persons: | | | | | | | | | |
| On same level: | | | | | | | | | |
| While escaping from another hazard | - | - | - | 3 | 3 | 3 | - | 11 | 11 |
| While handling material | - | - | - | 57 | 57 | 57 | - | 20 | 20 |
| Caused by handtool slipping or breaking | - | - | - | 5 | 5 | 5 | - | 14 | 14 |
| While operating or moving machinery | - | - | - | 4 | 4 | 4 | - | 8 | 8 |
| All other | - | - | - | 82 | 82 | 82 | - | 27 | 27 |
| From an elevation: | | | | | | | | | |
| While handling material | - | - | - | 25 | 25 | 25 | - | 24 | 24 |
| Caused by handtool slipping or breaking | - | - | - | 3 | 3 | 3 | - | 21 | 21 |
| While operating or moving machinery | - | - | - | 5 | 5 | 5 | - | 32 | 32 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | 26 | 26 | 26 | - | 23 | 23 |
| All other | 1 | - | - | 68 | 68 | 69 | - | 33 | 120 |
| Handling material: | | | | | | | | | |
| Prop, stull, or timber | - | - | - | 22 | 22 | 22 | - | 21 | 21 |
| Ore, valuable mineral | - | - | - | 20 | 20 | 20 | - | 31 | 31 |
| Rock or waste | - | - | - | 12 | 12 | 12 | - | 8 | 8 |
| Rail | - | - | - | 5 | 5 | 5 | - | 28 | 28 |
| Wire or wire rope | - | - | 1 | 14 | 15 | 15 | 300 | 30 | 48 |
| Conveyor pan | - | - | - | 1 | 1 | 1 | - | 53 | 53 |
| Flying particle while loading car | - | - | - | 2 | 2 | 2 | - | 3 | 3 |
| Flying particle while handling material | - | - | - | 30 | 30 | 30 | - | 8 | 8 |
| All other | - | - | 12 | 489 | 501 | 501 | 350 | 17 | 25 |
| Handtools: | | | | | | | | | |
| Pick | - | - | - | 1 | 1 | 1 | - | 3 | 3 |
| Hammer or sledge | - | - | - | 6 | 6 | 6 | - | 9 | 9 |
| Crowbar or bar | - | - | - | 15 | 15 | 15 | - | 15 | 15 |
| Shovel | - | - | - | 1 | 1 | 1 | - | 4 | 4 |
| Saw | - | - | - | 3 | 3 | 3 | - | 18 | 18 |
| Hand wrench | - | - | - | 1 | 1 | 1 | - | 30 | 30 |
| In hand of fellow worker | - | - | 1 | 5 | 6 | 6 | 150 | 23 | 45 |
| Flying particle from tool or object worked on | - | - | 1 | 11 | 12 | 12 | 1,800 | 13 | 162 |
| All other | - | - | 1 | 15 | 16 | 16 | 240 | 17 | 31 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | |
| Stepping on sharp object | - | - | - | 9 | 9 | 9 | - | 8 | 8 |
| Stepping on loose object | - | - | - | 29 | 29 | 29 | - | 11 | 11 |
| Striking or bumping against objects | - | - | - | 7 | 7 | 7 | - | 10 | 10 |

TABLE B-2. - Number and average severity of injuries by degree at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries | | | | | | Average severity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | Permanent partial | Temporary total | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | | |
| | | Total | Partial | | | | | | |
| MILLS - Continued | | | | | | | | | |
| Haulage: | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | |
| Switching, spragging, blocking, or breaking | - | - | - | 1 | 1 | 1 | - | 26 | 26 |
| Pulling, pushing, or dropping | - | - | - | 4 | 4 | 4 | - | 22 | 22 |
| Operating or riding | - | - | - | 1 | 1 | 1 | - | 11 | 11 |
| All other | - | - | - | 9 | 9 | 9 | - | 12 | 12 |
| Squeezed between cage, car or motor, and other object: | | | | | | | | | |
| Pulling, pushing, or dropping | - | - | - | 2 | 2 | 2 | - | 17 | 17 |
| Operating or riding | - | - | - | 1 | 1 | 1 | - | 14 | 14 |
| All other | - | - | - | 2 | 2 | 2 | - | 3 | 3 |
| Rerailing | - | - | - | 2 | 2 | 2 | - | 46 | 46 |
| Falling, slipping, or jumping into or from | - | - | - | 4 | 4 | 4 | - | 37 | 37 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | |
| Struck or run over | - | - | - | 13 | 13 | 13 | - | 11 | 11 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | 1 | 1 | 2 | 2 | 300 | 88 | 194 |
| All other | - | - | - | 24 | 24 | 24 | - | 22 | 22 |
| Railroad cars and locomotives | - | - | - | 38 | 38 | 38 | - | 28 | 28 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | - | 15 | 15 | 15 | - | 19 | 19 |
| All other | - | - | - | 31 | 31 | 31 | - | 31 | 31 |
| Water transportation: Rope or chain on boat or barge | - | - | - | 1 | 1 | 1 | - | 9 | 9 |
| Miscellaneous haulage: | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Rope or cable on haulage | - | - | - | 6 | 6 | 6 | - | 14 | 14 |
| Slip or strain from moving car by hand | - | - | - | 27 | 27 | 27 | - | 10 | 10 |
| Riding or getting on or off conveyor belt | - | - | - | 1 | 1 | 1 | - | 38 | 38 |
| Flying particle | - | - | - | 3 | 3 | 3 | - | 4 | 4 |
| All other | - | - | - | 15 | 15 | 15 | - | 17 | 17 |
| Explosions of gas or dust: | | | | | | | | | |
| Caused by electric arc | - | - | - | 2 | 2 | 2 | - | 96 | 96 |
| Explosion of gas | 1 | - | - | - | - | 1 | - | - | 6,000 |
| All other | - | 1 | - | 2 | 3 | 3 | - | 23 | 2,015 |
| Electricity: | | | | | | | | | |
| Power or lighting circuit | - | - | - | 3 | 3 | 3 | - | 23 | 23 |
| Locomotive or shuttle car | - | - | - | 1 | 1 | 1 | - | 16 | 16 |
| Cut-out switch and junction box | 1 | - | - | 2 | 2 | 3 | - | 11 | 2,007 |
| All other | 1 | - | - | 1 | 1 | 2 | - | 30 | 3,015 |
| Machinery: | | | | | | | | | |
| Belt conveyor | - | - | 5 | 40 | 45 | 45 | 1,915 | 36 | 245 |
| Chain, bucket, shaker, or screw conveyor | - | 1 | 3 | 13 | 17 | 17 | 163 | 34 | 408 |
| While moving loading machines or self-loading heads | - | - | - | 2 | 2 | 2 | - | 5 | 5 |
| Power drill; rotary or percussive (except rock bolting) | - | - | - | 8 | 8 | 8 | - | 12 | 12 |
| Power shovel, dragline, bulldozer, etc. | - | - | - | 6 | 6 | 6 | - | 7 | 7 |
| Stationary machinery | 1 | - | 12 | 50 | 62 | 63 | 642 | 41 | 250 |
| While moving machine (except chain, arc, longwall) | - | - | - | 11 | 11 | 11 | - | 16 | 16 |
| Particle set in motion by machinery (except rock bolting) | - | - | 1 | 10 | 11 | 11 | 918 | 7 | 90 |
| Mining or loading machinery under repair | - | - | - | 1 | 1 | 1 | - | 14 | 14 |
| All other | - | - | - | 15 | 15 | 15 | - | 25 | 25 |
| Suffocation (no flame or smoldering): Foreign gas | 1 | 1 | - | 7 | 8 | 9 | - | 15 | 1,345 |
| Fires or suffocation from fires | - | - | - | 2 | 2 | 2 | - | 47 | 47 |
| Miscellaneous causes: | | | | | | | | | |
| Flying particle from draft or wind | - | - | - | 11 | 11 | 11 | - | 5 | 5 |
| Acetylene or electric welding or cutting | - | - | - | 10 | 10 | 10 | - | 5 | 5 |
| Irritation or burn from caustic or acid | - | - | - | 22 | 22 | 22 | - | 11 | 11 |
| Burn from controlled fire | - | - | - | 34 | 34 | 34 | - | 16 | 16 |
| All other | - | - | - | 51 | 51 | 51 | - | 15 | 15 |
| Total or average, mills | 6 | 3 | 38 | 1,539 | 1,580 | 1,586 | 676 | 20 | 70 |
| Grand total or average | 24 | 4 | 60 | 2,422 | 2,486 | 2,510 | 773 | 22 | 107 |

TABLE B-3. - Fatal injuries and distribution by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964

| General work location and detailed cause | Injuries | | | | | | | | | | Percentage distribution |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Total | |
| UNDERGROUND MINES | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | |
| Falls of roof or back: While testing or barring down back | - | - | - | - | - | - | - | - | 1 | 1 | 14.29 |
| Sliding or falling material or objects: Falling equipment or machinery under repair | - | - | 1 | - | - | - | - | - | - | 1 | 14.29 |
| Slips or falls of persons: | | | | | | | | | | | |
| From an elevation: Down shaft or slope | - | - | - | - | - | - | - | - | 1 | 1 | 14.29 |
| Haulage: | | | | | | | | | | | |
| Cages, cars, or motors: Falling, slipping, or jumping into or from | 1 | - | - | - | - | - | - | - | - | 1 | 14.29 |
| Automobiles, gasoline or diesel trucks | - | - | - | - | - | - | - | - | 1 | 1 | 14.29 |
| Electricity: | | | | | | | | | | | |
| Trolley wire or pole | - | - | - | - | - | - | - | - | 1 | 1 | 14.29 |
| Locomotive or shuttle car | - | - | - | - | - | - | - | - | 1 | 1 | 14.29 |
| Total | 1 | - | 1 | - | - | - | - | - | 5 | 7 | - |
| Percentage distribution | 14.29 | - | 14.29 | - | - | - | - | - | 71.42 | - | - |
| Surface at underground: | | | | | | | | | | | |
| Haulage: Railroad cars and locomotives | 1 | - | - | - | - | - | - | - | - | 1 | 100.00 |
| Total | 1 | - | - | - | - | - | - | - | - | 1 | - |
| Percentage distribution | 100.00 | - | - | - | - | - | - | - | - | - | - |
| Total, underground mines | 2 | - | 1 | - | - | - | - | - | 5 | 8 | - |
| Percentage distribution | 25.00 | - | 12.50 | - | - | - | - | - | 62.50 | - | - |
| SURFACE MINING | | | | | | | | | | | |
| Falls of face or side: While mining | - | - | - | - | - | - | - | - | 2 | 2 | 20.00 |
| Handling material | - | - | 1 | - | - | - | - | - | - | 1 | 10.00 |
| Haulage: | | | | | | | | | | | |
| Automobiles, gasoline or diesel trucks | - | - | 1 | - | - | - | - | - | 4 | 5 | 50.00 |
| Machinery: | | | | | | | | | | | |
| Power shovel, dragline, bulldozer, etc. | - | - | - | - | - | - | - | - | 1 | 1 | 10.00 |
| All other | - | - | - | - | - | - | - | - | 1 | 1 | 10.00 |
| Total | - | - | 2 | - | - | - | - | - | 8 | 10 | - |
| Percentage distribution | - | - | 20.00 | - | - | - | - | - | 80.00 | - | - |
| Total, mining | 2 | - | 3 | - | - | - | - | - | 13 | 18 | - |
| Percentage distribution | 11.11 | - | 16.67 | - | - | - | - | - | 72.22 | - | - |
| MILLS | | | | | | | | | | | |
| Slips or falls of persons: From an elevation | - | - | - | - | - | - | - | - | 1 | 1 | 16.67 |
| Explosions of gas or dust: Explosion of gas | - | - | - | - | - | - | - | - | 1 | 1 | 16.67 |
| Electricity: | | | | | | | | | | | |
| Cut-out switch or junction box | - | - | - | - | - | - | - | - | 1 | 1 | 16.67 |
| All other | - | - | - | - | - | - | - | - | 1 | 1 | 16.67 |
| Machinery: Stationary machinery | - | - | - | - | - | - | - | - | 1 | 1 | 16.67 |
| Suffocation (no flame or smoldering): Foreign gas | - | - | 1 | - | - | - | - | - | - | 1 | 16.67 |
| Total, mills | - | - | 1 | - | - | - | - | - | 5 | 6 | - |
| Percentage distribution | - | - | 16.67 | - | - | - | - | - | 83.33 | - | - |
| Grand total | 2 | - | 4 | - | - | - | - | - | 18 | 24 | - |
| Percentage distribution | 8.33 | - | 16.67 | - | - | - | - | - | 75.00 | - | - |

TABLE B-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964

| General work location and detailed cause | Injuries: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | Percentage distribution | Average severity: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES | | | | | | | | | | | | | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | | | | | | | | | | | | | |
| Falls of roof or back: | | | | | | | | | | | | | | | | | | | | | | | |
| While mining | 3 | 2 | 3 | - | 1 | 1 | 1 | 5 | - | - | 16 | 3.55 | 9 | 8 | 70 | - | 11 | 4 | 40 | 15 | - | - | 24 |
| While loading | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .45 | - | - | 5 | - | - | - | 3 | - | - | - | 4 |
| While testing or barring down back | - | - | - | - | - | 1 | - | 2 | 1 | - | 4 | .89 | - | - | - | - | - | 6 | - | 6 | 3 | - | 5 |
| While setting or removing timber or other support | - | 1 | - | - | - | - | - | - | - | - | 1 | .22 | - | 3 | - | - | - | - | - | - | - | - | 3 |
| While preparing or installing rock bolt | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 139 | - | - | - | - | - | - | - | 139 |
| All other | 1 | 1 | - | - | - | 4 | 2 | 2 | - | 1 | 11 | 2.44 | 14 | 3 | - | - | - | 8 | 33 | 14 | - | 69 | 19 |
| Falls of face or side: | | | | | | | | | | | | | | | | | | | | | | | |
| While mining | - | - | - | - | - | 2 | 1 | 3 | - | 1 | 7 | 1.55 | - | - | - | - | - | 474 | 29 | 46 | - | 72 | 169 |
| While loading | 1 | - | - | - | - | - | - | - | - | - | 1 | .22 | 247 | - | - | - | - | - | - | - | - | - | 247 |
| While testing or barring down back | - | - | - | - | - | 1 | 2 | 1 | - | - | 4 | .89 | - | - | - | - | - | 19 | 30 | 48 | - | - | 32 |
| While moving machinery | - | - | - | - | - | - | 1 | - | - | - | 1 | .22 | - | - | - | - | - | - | 218 | - | - | - | 218 |
| All other | 2 | 1 | 4 | - | - | 1 | 4 | 3 | - | - | 15 | 3.33 | 49 | 1 | 20 | - | - | 5 | 10 | 3 | - | - | 15 |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Timber or other support | - | - | - | - | - | - | 1 | - | - | - | 1 | .22 | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Dropped or thrown by coworker | - | - | - | - | - | 2 | - | - | - | - | 2 | .45 | - | - | - | - | - | 5 | - | - | - | - | 5 |
| From car, bin, platform, or chute | - | - | - | - | - | 2 | - | 2 | - | - | 4 | .89 | - | - | - | - | - | 18 | - | 17 | - | - | 17 |
| From stockpile, dump, or gob | - | - | 1 | - | 1 | 1 | 1 | 4 | 1 | 1 | 10 | 2.22 | - | - | 2 | - | 10 | 18 | 60 | 65 | 1 | 26 | 38 |
| All other | 1 | 1 | 2 | - | - | 1 | - | 2 | - | - | 7 | 1.55 | 2 | 1 | 64 | - | - | 1 | - | 17 | - | - | 24 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .45 | - | - | 14 | - | - | - | 45 | - | - | - | 30 |
| While handling material | - | 1 | 6 | - | - | - | 2 | 1 | - | 1 | 11 | 2.44 | - | 9 | 43 | - | - | - | 6 | 4 | - | 44 | 30 |
| Caused by handtool slipping or breaking | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 79 | - | - | - | - | - | - | - | 79 |
| While operating or moving machinery | 1 | 1 | - | - | 1 | - | - | - | - | - | 3 | .67 | 5 | 1 | - | - | 64 | - | - | - | - | - | 23 |
| All other | 2 | - | 3 | - | 1 | - | 3 | 4 | - | - | 13 | 2.89 | 12 | - | 7 | - | 1 | - | 16 | 10 | - | - | 10 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | 1 | - | - | - | - | 1 | 1 | - | 3 | .67 | - | - | 5 | - | - | - | - | 24 | 8 | - | 12 |
| While operating or moving machinery | - | - | 2 | - | - | - | - | - | - | - | 2 | .45 | - | - | 5 | - | - | - | - | - | - | - | 5 |
| Caused by failure of scaffold, ladder, or other support | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 28 | - | - | - | - | - | - | - | 28 |
| All other | - | - | 2 | - | - | - | 1 | - | - | - | 3 | .67 | - | - | 6 | - | - | - | 3 | - | - | - | 5 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | 1 | - | 4 | 1 | - | 2 | - | 4 | - | 2 | 14 | 3.11 | 3 | - | 10 | 50 | - | 1 | - | 31 | - | 20 | 18 |
| Ore, valuable mineral | 1 | - | 3 | 1 | - | - | - | - | - | 1 | 6 | 1.33 | 18 | - | 13 | 65 | - | - | - | - | - | 20 | 24 |
| Rock or waste | - | - | 2 | - | - | - | 1 | - | - | - | 3 | .67 | - | - | 5 | - | - | - | 270 | - | - | - | 93 |
| Rail | - | - | 2 | - | - | 1 | 1 | 1 | - | - | 5 | 1.11 | - | - | 25 | - | - | 50 | 4 | 1 | - | - | 21 |
| Wire or wire rope | - | 2 | 11 | - | - | 2 | 1 | - | 1 | 1 | 18 | 4.00 | - | 3 | 14 | - | - | 101 | 14 | - | 4 | 20 | 22 |
| Conveyor pan | - | - | 3 | 1 | - | - | - | - | - | - | 4 | .89 | - | - | 7 | 39 | - | - | - | - | - | - | 15 |
| All other | 1 | 2 | 27 | 2 | 2 | 7 | 3 | 7 | - | 1 | 52 | 11.55 | 1 | 3 | 17 | 50 | 18 | 14 | 3 | 14 | - | 28 | 16 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Axe, hatchet, or adz | - | - | - | - | - | 3 | 1 | - | - | - | 4 | .89 | - | - | - | - | - | 18 | 2 | - | - | - | 14 |
| Hammer or sledge | - | - | 1 | - | - | - | - | 1 | - | - | 2 | .45 | - | - | 12 | - | - | - | - | 4 | - | - | 8 |
| Crowbar or bar | 2 | - | 1 | - | 1 | - | - | - | - | - | 4 | .89 | 3 | - | 10 | - | 3 | - | - | - | - | - | 5 |
| Shovel | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 6 | - | - | - | - | - | - | - | 6 |
| Handtool used to install rock bolt | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 3 | - | - | - | - | 3 |
| Flying particle from tool or object worked on | 1 | 2 | - | - | - | - | 2 | - | - | 1 | 6 | 1.33 | 2 | 4 | - | - | - | - | 6 | - | - | 24 | 8 |
| All other | 1 | - | 3 | - | 1 | 4 | 1 | 4 | - | - | 14 | 3.11 | 6 | - | 4 | - | 2 | 14 | 5 | 16 | - | - | 10 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on sharp object | - | - | - | - | - | - | - | 4 | - | - | 4 | .89 | - | - | - | - | - | - | - | 3 | - | - | 3 |
| Stepping on loose object | - | - | 3 | - | - | - | 1 | 4 | - | - | 8 | 1.77 | - | - | 9 | - | - | - | 5 | 32 | - | - | 20 |
| Striking or bumping against objects | - | - | 1 | - | - | - | 2 | - | - | - | 3 | .67 | - | - | 1 | - | - | - | 6 | - | - | - | 4 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | | | | | | | | | | | | | | | |
| Coupling or uncoupling | - | - | 1 | - | - | 1 | 1 | 2 | - | - | 5 | 1.11 | - | - | 4 | - | - | 75 | 19 | 15 | - | - | 26 |
| Switching, spragging, blocking, or braking | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 18 | - | - | - | - | - | - | - | 18 |
| Operating or riding | - | - | - | - | 1 | 1 | - | - | - | - | 2 | .45 | - | - | - | - | 1 | 22 | - | - | - | - | 12 |
| All other | - | - | 1 | - | - | - | - | 2 | - | - | 3 | .67 | - | - | 7 | - | - | - | - | 18 | - | - | 14 |

TABLE B-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries | | | | | | | | | | | Percentage distribution | Average severity | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
| UNDERGROUND MINES - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Haulage - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Squeezed between cage, car or motor, and other object: | | | | | | | | | | | | | | | | | | | | | | | |
| Coupling or uncoupling | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 37 | - | - | - | - | 37 |
| Pulling, pushing, or dropping | - | - | - | - | 1 | 2 | - | - | - | - | 3 | .67 | - | - | - | - | 149 | 6 | - | - | - | - | 53 |
| Operating or riding | 1 | - | 1 | - | - | - | - | - | - | - | 2 | .45 | 6 | - | 7 | - | - | - | - | - | - | - | 7 |
| All other | - | - | - | - | - | - | 1 | 2 | - | - | 3 | .67 | - | - | - | - | - | - | 15 | 44 | - | - | 34 |
| Derailment | - | - | - | - | - | 1 | 2 | - | - | - | 3 | .67 | - | - | - | - | - | 11 | 1,501 | - | - | - | 1,004 |
| Rerailing | 1 | - | 1 | - | - | 1 | - | 1 | - | - | 4 | .89 | 12 | - | 1 | - | - | 300 | - | 1 | - | - | 79 |
| Collision (while under control) | 1 | - | 3 | - | - | - | 1 | - | 2 | - | 7 | 1.55 | 14 | - | 14 | - | - | - | 56 | - | 45 | - | 29 |
| Runaway (while not under control) | - | - | - | - | - | - | - | 1 | 1 | - | 2 | .45 | - | - | - | - | - | - | - | 31 | 4 | - | 18 |
| Falling, slipping, or jumping into or from | - | - | 4 | - | - | 1 | - | 1 | - | - | 6 | 1.33 | - | - | 62 | - | - | 2 | - | 1 | - | - | 42 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck or run over | - | - | - | - | - | - | 2 | - | - | - | 2 | .45 | - | - | - | - | - | - | 1,506 | - | - | - | 1,506 |
| All other | 2 | - | 1 | - | 1 | - | 1 | - | - | - | 5 | 1.11 | 4 | - | 2 | - | 4 | - | 8 | - | - | - | 4 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | 1 | - | - | - | - | - | 1 | 1 | - | - | 3 | .67 | 1 | - | - | - | - | - | 5 | 26 | - | - | 11 |
| All other | - | - | - | - | 1 | - | 2 | - | 1 | 1 | 5 | 1.11 | - | - | - | - | 82 | - | 11 | - | 2 | 105 | 42 |
| Miscellaneous haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | - | - | - | - | - | 2 | - | 1 | - | - | 3 | .67 | - | - | - | - | - | 11 | - | 4 | - | - | 8 |
| Rope or cable on haulage | - | - | 2 | - | - | - | 1 | - | - | - | 3 | .67 | - | - | 51 | - | - | - | 136 | - | - | - | 79 |
| Animal on haulage | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 48 | - | - | - | - | 48 |
| Slip or strain from moving car by hand | 1 | - | 4 | - | - | - | - | - | - | 1 | 6 | 1.33 | 18 | - | 19 | - | - | - | - | - | - | 105 | 33 |
| Riding or getting on or off conveyor belt | - | - | 1 | - | - | - | - | 1 | - | - | 2 | .45 | - | - | 88 | - | - | - | - | 50 | - | - | 69 |
| Flying particle | - | 3 | - | - | - | - | - | - | - | 1 | 4 | .89 | - | 2 | - | - | - | - | - | - | - | 44 | 13 |
| All other | 1 | - | 2 | - | 1 | - | 1 | - | - | 1 | 6 | 1.33 | 18 | - | 79 | - | 2 | - | 56 | - | - | 28 | 44 |
| Explosives: | | | | | | | | | | | | | | | | | | | | | | | |
| Misfire or digging into unexploded hole | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .45 | - | - | 11 | - | - | - | 167 | - | - | - | 89 |
| Flying fragments | - | - | - | - | - | - | - | 1 | 1 | - | 2 | .45 | - | - | - | - | - | - | - | 46 | 8 | - | 27 |
| Insufficient warning, short fuse, or short cable | 1 | 1 | - | - | - | - | - | - | - | - | 2 | .45 | 12 | 1 | - | - | - | - | - | - | - | - | 7 |
| Electricity: | | | | | | | | | | | | | | | | | | | | | | | |
| Trolley wire or pole | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 9 | - | - | - | - | 9 |
| Locomotive or shuttle car | - | - | - | - | - | 1 | 1 | - | - | - | 2 | .45 | - | - | - | - | - | 9 | 3 | - | - | - | 6 |
| Mining or loading machine | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 53 | - | - | - | - | 53 |
| Cut-out switch or junction box | - | 2 | - | - | - | - | - | - | - | - | 2 | .45 | - | 2 | - | - | - | - | - | - | - | - | 2 |
| Cable, cable arc, or blowup | - | 1 | - | - | - | 2 | - | - | 2 | - | 5 | 1.11 | - | 3 | - | - | - | 12 | - | - | 15 | - | 11 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| While moving machine (chain, arc, longwall) | - | - | 1 | - | 1 | - | - | - | - | - | 2 | .45 | - | - | 10 | - | 14 | - | - | - | - | - | 12 |
| While setting up (jack, bar, skid) | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 11 | - | - | - | - | - | - | - | 11 |
| While operating (cutter bar, chain, bit) | - | - | - | - | 1 | - | - | - | - | - | 1 | .22 | - | - | - | - | 12 | - | - | - | - | - | 12 |
| Belt conveyor | - | - | 1 | - | - | 1 | - | - | - | - | 2 | .45 | - | - | 12 | - | - | 7 | - | - | - | - | 10 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | - | - | 1 | - | - | - | - | 2 | .45 | - | - | 2 | - | - | 49 | - | - | - | - | 26 |
| Loading machine (including self-loading heads) | 1 | - | 3 | - | - | - | 1 | 1 | 1 | - | 7 | 1.55 | 11 | - | 64 | - | - | - | 5 | 59 | 1 | - | 39 |
| While moving loading machines or self loading heads | - | - | - | - | - | - | 1 | 1 | - | - | 2 | .45 | - | - | - | - | - | - | 10 | 32 | - | - | 21 |
| Mucking machine, mechanical loader | - | - | 1 | - | 1 | 2 | - | 1 | - | - | 5 | 1.11 | - | - | 15 | - | 90 | 102 | - | 6 | - | - | 63 |
| Power drill; rotary or percussive (except rock bolting) | - | - | 4 | - | 1 | 3 | 1 | 3 | 1 | 1 | 14 | 3.11 | - | - | 15 | - | 87 | 9 | 11 | 14 | 4 | 45 | 20 |
| Power shovel, dragline, bulldozer, etc. | 1 | - | 1 | - | - | - | 2 | - | - | - | 4 | .89 | 23 | - | 59 | - | - | - | 50 | - | - | - | 46 |
| Stationary machinery | - | - | - | - | - | - | - | 1 | - | - | 1 | .22 | - | - | - | - | - | - | - | 2,400 | - | - | 2,400 |
| While moving machine (except chain, arc, longwall) | - | - | 1 | - | - | 1 | 1 | - | - | 1 | 4 | .89 | - | - | 5 | - | - | 1 | 3 | - | - | 69 | 20 |
| Particle set in motion by machinery (except rock bolting) | 1 | 6 | - | - | - | - | - | - | - | - | 7 | 1.55 | 14 | 4 | - | - | - | - | - | - | - | - | 5 |
| Continuous mining machine | - | - | - | - | - | - | - | 1 | - | - | 1 | .22 | - | - | - | - | - | - | - | 6 | - | - | 6 |
| All other | - | - | 1 | - | - | 1 | - | 1 | - | - | 3 | .67 | - | - | 12 | - | - | 7 | - | 70 | - | - | 30 |
| Suffocation (no flame or smoldering): | | | | | | | | | | | | | | | | | | | | | | | |
| Natural mine gas or oxygen deficient | - | - | 1 | - | - | - | - | - | - | - | 1 | .22 | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Foreign gas | - | - | 4 | - | - | - | - | - | - | - | 4 | .89 | - | - | 45 | - | - | - | - | - | - | - | 45 |

TABLE B-4.- Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries | | | | | | | | | | | Percentage distribution | Average severity | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
| UNDERGROUND MINES - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Miscellaneous causes: | | | | | | | | | | | | | | | | | | | | | | | |
| Flying particle from draft or wind | - | 2 | - | - | - | - | - | - | - | - | 2 | .45 | - | 10 | - | - | - | - | - | - | - | - | 10 |
| Irritation or burn from caustic or acid | - | 2 | 2 | - | - | - | - | - | - | - | 4 | .89 | - | 5 | 5 | - | - | - | - | - | - | - | 5 |
| Burn from controlled fire | - | - | - | - | - | 1 | - | - | - | - | 1 | .22 | - | - | - | - | - | 3 | - | - | - | - | 3 |
| All other | 1 | 3 | 2 | 1 | - | - | 1 | - | - | - | 8 | 1.77 | 3 | 2 | 16 | 51 | - | - | 5 | - | - | - | 12 |
| Total or average | 31 | 34 | 138 | 6 | 17 | 62 | 56 | 77 | 13 | 16 | 450 | - | 19 | 4 | 23 | 51 | 33 | 40 | 136 | 53 | 12 | 46 | 44 |
| Percentage distribution | 6.89 | 7.55 | 30.67 | 1.33 | 3.78 | 13.78 | 12.44 | 17.11 | 2.89 | 3.56 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Surface at underground: | | | | | | | | | | | | | | | | | | | | | | | |
| Sliding or falling material or objects | - | - | - | - | - | - | 1 | - | - | - | 1 | 1.43 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | 1 | 1 | - | - | 4 | - | - | - | 6 | 8.57 | - | - | 6 | 42 | - | - | 11 | - | - | - | 16 |
| All other | - | - | 1 | - | - | - | - | 1 | - | - | 2 | 2.86 | - | - | 2 | - | - | - | - | 1 | - | - | 2 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.43 | - | - | 6 | - | - | - | - | - | - | - | 6 |
| While operating or moving machinery | - | - | - | 1 | - | - | - | - | - | - | 1 | 1.43 | - | - | - | 43 | - | - | - | - | - | - | 43 |
| Caused by failure of scaffold, ladder, or other support | - | - | - | - | - | - | - | 1 | - | - | 1 | 1.43 | - | - | - | - | - | - | - | 64 | - | - | 64 |
| All other | - | - | - | - | 1 | - | - | - | - | - | 1 | 1.43 | - | - | - | - | 51 | - | - | - | - | - | 51 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | - | - | - | - | - | - | - | - | 1 | 1 | 2 | 2.86 | - | - | - | - | - | - | - | - | 27 | 20 | 24 |
| Ore, valuable mineral | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.43 | - | - | 12 | - | - | - | - | - | - | - | 12 |
| Rail | - | - | - | 1 | - | - | - | - | - | - | 1 | 1.43 | - | - | - | 41 | - | - | - | - | - | - | 41 |
| Wire or wire rope | 1 | - | - | - | - | - | - | - | - | - | 1 | 1.43 | 3 | - | - | - | - | - | - | - | - | - | 3 |
| All other | - | - | 8 | - | 2 | 2 | 1 | 1 | 1 | 1 | 16 | 22.85 | - | - | 83 | - | 12 | 83 | 226 | 15 | 7 | 28 | 71 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Hammer or sledge | - | - | - | - | - | 1 | - | - | - | - | 1 | 1.43 | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Crowbar or bar | 1 | - | - | - | - | - | - | - | - | - | 1 | 1.43 | 1 | - | - | - | - | - | - | - | - | - | 1 |
| In hand of fellow worker | - | - | - | - | - | - | 1 | - | - | - | 1 | 1.43 | - | - | - | - | - | - | 5 | - | - | - | 5 |
| Flying particle from tool or object worked on | - | 1 | - | - | - | - | - | - | - | - | 1 | 1.43 | - | 3 | - | - | - | - | - | - | - | - | 3 |
| All other | - | - | 1 | - | - | - | 1 | - | - | - | 2 | 2.86 | - | - | 19 | - | - | - | 1 | - | - | - | 10 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on loose object | - | - | - | - | - | - | - | 2 | - | - | 2 | 2.86 | - | - | - | - | - | - | - | 15 | - | - | 15 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Unspecified | - | - | - | - | - | - | - | 1 | - | - | 1 | 1.43 | - | - | - | - | - | - | - | 4 | - | - | 4 |
| Railroad cars and locomotives | - | - | 2 | - | 1 | - | - | 2 | - | - | 5 | 7.14 | - | - | 7 | - | 88 | - | - | 9 | - | - | 24 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 2 | - | - | 1 | - | - | - | - | 3 | 4.28 | - | - | 19 | - | 94 | - | - | - | - | - | 44 |
| All other | - | - | - | - | - | - | 1 | - | - | - | 1 | 1.43 | - | - | - | - | - | - | 66 | - | - | - | 66 |
| Water transportation: Rope or chain on boat or barge | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.43 | - | - | 6 | - | - | - | - | - | - | - | 6 |
| Miscellaneous haulage: Slip or strain from moving car by hand | - | - | 1 | - | - | - | - | - | - | - | 1 | 1.43 | - | - | 45 | - | - | - | - | - | - | - | 45 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| Belt conveyor | - | - | - | - | - | 1 | - | - | - | - | 1 | 1.43 | - | - | - | - | - | 11 | - | - | - | - | 11 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | - | - | 1 | - | - | - | - | 2 | 2.85 | - | - | 3 | - | - | 1,250 | - | - | - | - | 627 |
| Power shovel, dragline, bulldozer, etc. | - | - | 1 | - | - | 1 | - | - | 1 | - | 3 | 4.28 | - | - | 9 | - | - | 41 | - | - | 23 | - | 24 |
| Stationary machinery | - | - | - | - | 1 | 2 | - | - | - | - | 3 | 4.28 | - | - | - | - | - | 1,020 | - | - | - | - | 685 |
| While moving machine(except chain, arc, longwall) | - | - | - | 1 | - | 1 | - | - | - | - | 2 | 2.86 | - | - | - | 82 | - | 7 | - | - | - | - | 45 |
| Particle set in motion by machinery (except rock bolting) | - | 1 | - | - | - | - | - | - | - | - | 1 | 1.43 | - | 1 | - | - | - | - | - | - | - | - | 1 |

TABLE B-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | Percentage distribution | Average severity: Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Surface at underground - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Miscellaneous causes: | | | | | | | | | | | | | | | | | | | | | | | |
| Acetylene or electric welding or cutting | 1 | - | - | - | - | - | 1 | 1 | - | - | 3 | 4.28 | 16 | - | - | - | - | - | 23 | 6 | - | - | 15 |
| All other | - | - | - | - | - | - | - | - | - | 1 | 1 | 1.43 | - | - | - | - | - | - | - | - | - | 28 | 28 |
| Total or average | 3 | 2 | 21 | 4 | 5 | 10 | 10 | 9 | 3 | 3 | 70 | - | 7 | 2 | 39 | 52 | 35 | 361 | 37 | 15 | 19 | 25 | 78 |
| Percentage distribution | 4.28 | 2.86 | 30.00 | 5.71 | 7.14 | 14.29 | 14.29 | 12.86 | 4.29 | 4.29 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total or average, underground mines | 34 | 36 | 159 | 10 | 22 | 72 | 66 | 86 | 16 | 19 | 520 | - | 18 | 4 | 25 | 51 | 34 | 84 | 121 | 49 | 13 | 43 | 49 |
| Percentage distribution | 6.54 | 6.92 | 30.58 | 1.92 | 4.23 | 13.85 | 12.69 | 16.54 | 3.08 | 3.65 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| SURFACE MINING | | | | | | | | | | | | | | | | | | | | | | | |
| Falls of face or side: | | | | | | | | | | | | | | | | | | | | | | | |
| While mining | - | - | - | - | - | 1 | - | - | - | - | 1 | .26 | - | - | - | - | - | 15 | - | - | - | - | 15 |
| While loading | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 42 | - | - | - | - | - | - | - | 42 |
| All other | - | - | - | - | - | - | - | 1 | 1 | - | 2 | .52 | - | - | - | - | - | - | - | 15 | 7 | - | 11 |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Dropped or thrown by coworker | - | - | - | - | - | 1 | - | 1 | - | - | 2 | .52 | - | - | - | - | - | 6 | - | 16 | - | - | 11 |
| From car, bin, platform, or chute | 2 | - | 2 | - | - | 2 | - | 2 | - | 2 | 10 | 2.59 | 29 | - | 26 | - | - | 8 | - | 36 | - | 76 | 35 |
| From stockpile, dump, or goo | - | - | - | - | - | - | - | 1 | - | - | 1 | .26 | - | - | - | - | - | - | - | 14 | - | - | 14 |
| All other | 1 | - | 1 | - | - | - | 1 | - | 1 | 1 | 5 | 1.29 | 2 | - | 24 | - | - | - | 2 | - | 22 | 76 | 25 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | - | - | 1 | - | - | - | - | 1 | - | 1 | 3 | .78 | - | - | 9 | - | - | - | - | 21 | - | 36 | 22 |
| While handling material | - | - | 5 | - | 1 | 2 | 3 | - | - | 6 | 17 | 4.40 | - | - | 38 | - | 1 | 3 | 6 | - | - | 36 | 25 |
| Caused by handtool slipping or breaking | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 1 | - | - | - | - | - | - | - | 1 |
| While operating or moving machinery | - | - | 1 | - | - | - | - | 1 | - | - | 2 | .52 | - | - | 9 | - | - | - | - | 2 | - | - | 6 |
| All other | - | - | 4 | - | - | 1 | 4 | 2 | - | 3 | 14 | 3.63 | - | - | 6 | - | - | 21 | 76 | 2 | - | 33 | 32 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While handling material | - | - | 3 | - | - | - | 1 | - | 1 | 2 | 7 | 1.81 | - | - | 55 | - | - | - | 91 | - | 4 | 36 | 48 |
| Caused by handtool slipping or breaking | - | - | - | - | - | - | - | 1 | - | - | 1 | .26 | - | - | - | - | - | - | - | 68 | - | - | 68 |
| While operating or moving machinery | - | - | 7 | 1 | - | - | - | - | - | 2 | 10 | 2.59 | - | - | 54 | 77 | - | - | - | - | - | 36 | 53 |
| Caused by failure of scaffold, ladder, or other support | - | - | 2 | - | - | - | 1 | - | 1 | 1 | 5 | 1.29 | - | - | 63 | - | - | - | 60 | - | 7 | 65 | 52 |
| All other | - | - | 4 | 1 | - | - | 1 | 1 | 1 | - | 8 | 2.07 | - | - | 74 | 28 | - | - | 30 | 2 | 11 | - | 46 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop, stull, or timber | - | - | 5 | - | - | - | - | - | - | 3 | 8 | 2.07 | - | - | 60 | - | - | - | - | - | - | 23 | 46 |
| Rock or waste | 1 | - | 2 | - | - | - | - | - | - | 1 | 4 | 1.04 | 1 | - | 12 | - | - | - | - | - | - | 24 | 12 |
| Rail | - | - | 2 | - | - | - | - | 1 | - | 1 | 4 | 1.04 | - | - | 45 | - | - | - | - | 97 | - | 24 | 53 |
| Wire or wire rope | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 3 | - | - | - | - | - | - | - | 3 |
| Flying particle while handling material | - | 1 | - | - | - | - | - | - | - | - | 1 | .26 | - | 3 | - | - | - | - | - | - | - | - | 3 |
| All other | 2 | - | 32 | 2 | 2 | 19 | 10 | 6 | 3 | 17 | 93 | 24.09 | 19 | - | 17 | 47 | 18 | 29 | 25 | 5 | 3 | 24 | 21 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Pick | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 3 | - | - | - | - | - | - | - | 3 |
| Hammer or sledge | - | - | - | - | - | 3 | - | 3 | - | 1 | 7 | 1.81 | - | - | - | - | - | 40 | - | 9 | - | 18 | 23 |
| Crowbar or bar | - | - | 1 | - | - | 1 | 1 | 1 | - | 1 | 5 | 1.29 | - | - | 56 | - | - | 3 | 1 | 3 | - | 18 | 16 |
| In hand of fellow worker | - | - | - | - | - | - | - | 1 | - | - | 1 | .26 | - | - | - | - | - | - | - | 30 | - | - | 30 |
| Flying particle from tool or object worked on | - | 1 | - | - | - | - | - | - | - | - | 1 | .26 | - | 1 | - | - | - | - | - | - | - | - | 1 |
| All other | 1 | 1 | 5 | - | - | 2 | - | 1 | - | 1 | 11 | 2.85 | 1 | 4 | 11 | - | - | 22 | - | 19 | - | 18 | 13 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on sharp object | - | - | - | - | - | - | - | 3 | - | - | 3 | .78 | - | - | - | - | - | - | - | 10 | - | - | 10 |
| Stepping on loose object | - | - | 1 | - | - | - | 3 | 7 | - | 2 | 13 | 3.37 | - | - | 4 | - | - | - | 19 | 14 | - | 18 | 15 |
| Striking or bumping against objects | - | - | - | - | - | 1 | - | 1 | - | - | 2 | .52 | - | - | - | - | - | 10 | - | 4 | - | - | 7 |

TABLE B-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries | | | | | | | | | | | Percentage distribution | Average severity | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
| SURFACE MINING - Continued | | | | | | | | | | | | | | | | | | | | | | | |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between: Coupling or uncoupling | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 5 | - | - | - | - | - | - | - | 5 |
| Rerailing | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .52 | - | - | 8 | - | - | - | 51 | - | - | - | 30 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck or run over | - | - | - | - | - | - | 1 | 1 | - | - | 2 | .52 | - | - | - | - | - | - | 60 | 56 | - | - | 58 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | - | - | - | - | - | 1 | - | - | 1 | .26 | - | - | - | - | - | - | - | 152 | - | - | 152 |
| Railroad cars and locomotives | - | - | - | - | 1 | 1 | 2 | 1 | - | 4 | 9 | 2.33 | - | - | - | - | 1 | 11 | 4 | 16 | - | 124 | 59 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 4 | - | - | 2 | 6 | - | - | 4 | 16 | 4.14 | - | - | 13 | - | - | 6 | 45 | - | - | 119 | 51 |
| All other | 1 | - | 5 | 1 | 4 | 2 | 4 | - | 2 | 4 | 23 | 5.96 | 10 | - | 25 | 49 | 54 | 21 | 18 | - | 3,003 | 119 | 304 |
| Miscellaneous haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Rope or cable on haulage | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 10 | - | - | - | - | - | - | - | 10 |
| Slip or strsin from moving car by hand | - | - | - | - | - | 1 | 1 | - | - | - | 2 | .52 | - | - | - | - | - | 2 | 15 | - | - | - | 9 |
| Flying particle | - | 1 | - | - | - | - | - | - | - | - | 1 | .26 | - | 6 | - | - | - | - | - | - | - | - | 6 |
| All other | - | - | - | - | - | - | 1 | - | - | - | 1 | .26 | - | - | - | - | - | - | 2 | - | - | - | 2 |
| Electricity: | | | | | | | | | | | | | | | | | | | | | | | |
| Power or lighting circuit | - | 1 | - | - | - | 1 | - | - | - | - | 2 | .52 | - | 5 | - | - | - | 1,200 | - | - | - | - | 603 |
| All other | - | - | - | - | - | 1 | - | - | - | - | 1 | .26 | - | - | - | - | - | 28 | - | - | - | - | 28 |
| Machinery: | | | | | | | | | | | | | | | | | | | | | | | |
| Belt conveyor | - | - | - | - | 1 | 3 | 1 | - | - | 2 | 7 | 1.81 | - | - | - | - | 37 | 45 | 66 | - | - | 168 | 82 |
| Chain, bucket, shaker, or screw conveyor | - | - | - | - | - | 1 | - | - | - | - | 1 | .26 | - | - | - | - | - | 3,000 | - | - | - | - | 3,000 |
| While moving loading machine, or self loading heads | 1 | - | - | - | - | - | - | - | - | - | 1 | .26 | 58 | - | - | - | - | - | - | - | - | - | 58 |
| Mucking mschine, mechanical losder | - | - | 2 | | | - | | | - | 1 | 3 | .78 | - | - | 4 | - | - | - | - | - | - | 102 | 37 |
| Power drill; rotsry or percussive (except rock bolting) | - | - | - | | | - | 1 | 3 | - | 2 | 6 | 1.55 | - | - | - | - | - | - | 15 | 25 | - | 102 | 49 |
| Power shovel, dragline, bulldozers, etc. | 1 | - | 2 | - | 2 | 2 | 2 | 2 | - | 3 | 14 | 3.63 | 142 | - | 21 | - | 16 | 42 | 26 | 18 | - | 89 | 46 |
| Stationary mschinery | - | - | 1 | - | - | 1 | - | - | - | 1 | 3 | .78 | - | - | 4 | - | - | 100 | - | - | - | 74 | 59 |
| While moving machine (except chain, arc, longwsll) | - | - | 2 | 1 | - | 2 | - | 1 | - | 2 | 8 | 2.07 | - | - | 1,245 | 51 | - | 33 | - | 3 | - | 62 | 342 |
| Particle set in motion by mschinery (except rock bolting) | - | 3 | - | - | - | - | - | - | - | - | 3 | .78 | - | 14 | - | - | - | - | - | - | - | - | 14 |
| All other | 2 | 1 | 1 | - | 1 | 4 | - | 1 | - | 1 | 11 | 2.85 | 4 | 54 | 18 | - | 60 | 32 | - | 164 | - | 28 | 42 |
| Mine fires or suffocation from fires: Burning mineral or timber | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Miscellsneous causea: | | | | | | | | | | | | | | | | | | | | | | | |
| Flying particle from draft or wind | - | 1 | - | - | - | - | - | - | - | - | 1 | .26 | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Acetylene or electric welding or cutting | - | 4 | - | - | - | - | - | - | - | - | 4 | 1.03 | - | 4 | - | - | - | - | - | - | - | - | 4 |
| Irritation or burn from caustic or acid | 1 | - | - | - | 1 | - | - | - | 3 | - | 5 | 1.29 | 3 | - | - | - | 5 | - | - | - | 7 | - | 6 |
| Burn from controlled fire | - | - | - | - | - | 1 | - | - | 2 | - | 3 | .78 | - | - | - | - | - | 7 | - | - | 4 | - | 5 |
| All other | 2 | - | 2 | - | - | - | 1 | - | 1 | 1 | 7 | 1.81 | 23 | - | 42 | - | - | - | 5 | - | 3 | 28 | 24 |
| Pneumoconioais | - | - | 1 | - | - | - | - | - | - | - | 1 | .26 | - | - | 23 | - | - | - | - | - | - | - | 23 |
| Total or average | 15 | 14 | 106 | 6 | 13 | 55 | 46 | 45 | 16 | 70 | 386 | - | 24 | 9 | 50 | 50 | 30 | 102 | 31 | 24 | 381 | 57 | 64 |
| Percentage distribution | 3.89 | 3.63 | 27.46 | 1.55 | 3.37 | 14.25 | 11.92 | 11.66 | 4.14 | 18.13 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total or average, mining | 49 | 50 | 265 | 16 | 35 | 127 | 112 | 131 | 32 | 89 | 906 | - | 20 | 5 | 35 | 51 | 32 | 92 | 84 | 40 | 197 | 54 | 55 |
| Percentage distribution | 5.41 | 5.52 | 29.25 | 1.77 | 3.86 | 14.02 | 12.36 | 14.46 | 3.53 | 9.82 | - | - | - | - | - | - | - | - | - | - | - | - | - |

TABLE B-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

| General work location and detailed cause | Injuries: Head, face, neck | Injuries: Eye | Injuries: Trunk | Injuries: Hernia | Injuries: Upper extremities | Injuries: Hand and fingers | Injuries: Lower extremities | Injuries: Foot and toes | Injuries: General (multiple) | Injuries: Not stated | Injuries: Total | Percentage distribution | Average severity: Head, face, neck | Average severity: Eye | Average severity: Trunk | Average severity: Hernia | Average severity: Upper extremities | Average severity: Hand and fingers | Average severity: Lower extremities | Average severity: Foot and toes | Average severity: General (multiple) | Average severity: Not stated | Average severity: Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MILLS | | | | | | | | | | | | | | | | | | | | | | | |
| Sliding or falling material or objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Timber or other support | - | - | - | - | - | - | 1 | 1 | - | - | 2 | 0.13 | - | - | - | - | - | - | 20 | 20 | - | - | 20 |
| Dropped or thrown by coworker | 1 | - | 2 | - | - | 1 | - | 2 | - | 2 | 8 | .51 | 1 | - | 11 | - | - | 26 | - | 5 | - | 17 | 12 |
| From car, bin, platform, or chute | 4 | - | 5 | - | 3 | 4 | 3 | 6 | 1 | 2 | 28 | 1.77 | 21 | - | 9 | - | 6 | 23 | 71 | 9 | 4 | 17 | 19 |
| Falling cage | - | - | - | - | - | - | 1 | - | - | - | 1 | .06 | - | - | - | - | - | - | 7 | - | - | - | 7 |
| Falling equipment or machinery under repair | - | - | - | - | - | - | 1 | 2 | - | 1 | 4 | .25 | - | - | - | - | - | - | 5 | 45 | - | 17 | 28 |
| From stockpile, dump, or gob | - | - | - | - | - | - | 1 | - | - | - | 1 | .06 | - | - | - | - | - | - | 36 | - | - | - | 36 |
| All other | 1 | 2 | - | - | - | 1 | 1 | 5 | - | 3 | 13 | .82 | 10 | 4 | - | - | - | 3 | 2 | 8 | - | 28 | 11 |
| Slips or falls of persons: | | | | | | | | | | | | | | | | | | | | | | | |
| On same level: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | - | - | 1 | - | - | - | 1 | - | - | 1 | 3 | .19 | - | - | 2 | - | - | - | 5 | - | - | 25 | 11 |
| While handling material | 3 | - | 24 | 7 | 3 | 3 | 7 | 4 | - | 6 | 57 | 3.61 | 5 | - | 12 | 37 | 31 | 7 | 36 | 5 | - | 26 | 20 |
| Caused by handtool slipping or breaking | - | - | 3 | - | - | - | 1 | - | - | 1 | 5 | .32 | - | - | 14 | - | - | - | 1 | - | - | 25 | 14 |
| While operating or moving machinery | - | - | 1 | - | 2 | - | - | 1 | - | - | 4 | .25 | - | - | 9 | - | 6 | - | - | 11 | - | - | 8 |
| All other | - | 1 | 28 | - | 8 | 7 | 15 | 12 | - | 11 | 82 | 5.19 | - | 2 | 27 | - | 13 | 19 | 52 | 9 | - | 27 | 27 |
| From an elevation: | | | | | | | | | | | | | | | | | | | | | | | |
| While escaping another hazard | - | - | 8 | - | 2 | 1 | 4 | 3 | 2 | 5 | 25 | 1.58 | - | - | 19 | - | 42 | 1 | 19 | 12 | 59 | 25 | 24 |
| Caused by handtool slipping or breaking | - | - | 2 | - | 1 | - | - | - | - | - | 3 | .19 | - | - | 13 | - | 37 | - | - | - | - | - | 21 |
| While operating or moving machinery | - | - | 2 | - | - | - | - | 2 | - | 1 | 5 | .32 | - | - | 2 | - | - | - | - | 54 | - | 48 | 32 |
| Caused by failure of scaffold, ladder, or other support | 3 | - | 5 | 1 | 2 | - | 3 | 4 | - | 8 | 26 | 1.65 | 9 | - | 41 | 56 | 9 | - | 13 | 11 | - | 28 | 23 |
| All other | - | - | 26 | 1 | 2 | 2 | 14 | 15 | 3 | 5 | 68 | 4.30 | - | - | 44 | 43 | 7 | 2 | 15 | 22 | 6 | 102 | 33 |
| Handling material: | | | | | | | | | | | | | | | | | | | | | | | |
| Prop atull, or timber | - | - | 7 | 1 | 1 | 3 | 1 | 2 | - | 7 | 22 | 1.39 | - | - | 16 | 63 | 27 | 12 | 3 | 15 | - | 27 | 21 |
| Ore, valuable mineral | 1 | - | 7 | - | 2 | 2 | 1 | - | - | 7 | 20 | 1.27 | 1 | - | 45 | - | 12 | 6 | 2 | - | - | 37 | 31 |
| Rock or waste | - | - | 7 | - | - | - | 1 | 1 | - | 3 | 12 | .76 | - | - | 9 | - | - | - | 1 | 5 | - | 11 | 8 |
| Rail | - | - | 2 | - | - | - | - | 2 | - | 1 | 5 | .32 | - | - | 16 | - | - | - | - | 48 | - | 11 | 28 |
| Wire or wire rope | - | - | 3 | 1 | - | 4 | - | 1 | - | 6 | 15 | .95 | - | - | 5 | 65 | - | 94 | - | 6 | - | 42 | 48 |
| Conveyor pan | - | - | 1 | - | - | - | - | - | - | - | 1 | .06 | - | - | 53 | - | - | - | - | - | - | - | 53 |
| Flying particle while loading car | - | 2 | - | - | - | - | - | - | - | - | 2 | .13 | - | 3 | - | - | - | - | - | - | - | - | 3 |
| Flying particle while handling material | - | 22 | - | - | - | - | - | - | - | 8 | 30 | 1.90 | - | 5 | - | - | - | - | - | - | - | 16 | 8 |
| All other | 15 | 7 | 216 | 13 | 15 | 82 | 28 | 82 | 3 | 40 | 501 | 31.70 | 9 | 13 | 26 | 61 | 18 | 25 | 58 | 17 | 6 | 19 | 25 |
| Handtools: | | | | | | | | | | | | | | | | | | | | | | | |
| Pick | - | - | - | - | - | - | - | 1 | - | - | 1 | .06 | - | - | - | - | - | - | - | 3 | - | - | 3 |
| Hammer or sledge | 1 | - | - | - | - | 2 | 2 | 1 | - | - | 6 | .38 | 7 | - | - | - | - | 6 | 17 | 1 | - | - | 9 |
| Crowbar or bar | 1 | - | 2 | - | 1 | 3 | 1 | 5 | - | 2 | 15 | .95 | 3 | - | 7 | - | 1 | 1 | 13 | 18 | - | 50 | 15 |
| Shovel | - | - | 1 | - | - | - | - | - | - | - | 1 | .06 | - | - | 4 | - | - | - | - | - | - | - | 4 |
| Saw | - | - | - | - | - | 3 | - | - | - | - | 3 | .19 | - | - | - | - | - | 18 | - | - | - | - | 18 |
| Hand wrench | - | - | - | - | - | - | 1 | - | - | - | 1 | .06 | - | - | - | - | - | - | 30 | - | - | - | 30 |
| In hand of fellow worker | - | 1 | 2 | - | - | 1 | - | - | 1 | 1 | 6 | .38 | - | 9 | 28 | - | - | 150 | - | - | 2 | 51 | 45 |
| Flying particle from tool or object worked on | - | 8 | - | - | 1 | 1 | - | - | - | 2 | 12 | .76 | - | 228 | - | - | 7 | 15 | - | - | - | 50 | 162 |
| All other | 1 | 1 | 2 | - | - | 5 | - | 4 | - | 3 | 16 | 1.01 | 5 | 7 | 42 | - | - | 7 | - | 66 | - | 36 | 31 |
| Stepping or kneeling on sharp or loose objects: | | | | | | | | | | | | | | | | | | | | | | | |
| Stepping on sharp object | - | - | - | - | - | - | - | 7 | - | 2 | 9 | .57 | - | - | - | - | - | - | - | 3 | - | 29 | 8 |
| Stepping on loose object | - | - | 7 | - | - | 2 | 5 | 14 | - | 1 | 29 | 1.84 | - | - | 13 | - | - | 11 | 10 | 10 | - | 9 | 11 |
| Striking or bumping against objects | 2 | - | - | - | 1 | - | 3 | - | - | 1 | 7 | .44 | 8 | - | - | - | 3 | - | 14 | - | - | 10 | 10 |
| Haulage: | | | | | | | | | | | | | | | | | | | | | | | |
| Cages, cars, or motors: | | | | | | | | | | | | | | | | | | | | | | | |
| Struck, run over, or squeezed between: | | | | | | | | | | | | | | | | | | | | | | | |
| Switching, spragging, blocking or braking | - | - | - | - | - | - | - | 1 | - | - | 1 | .06 | - | - | - | - | - | - | - | 26 | - | - | 26 |
| Pulling, pushing, or dropping | - | - | - | 1 | - | - | 1 | 2 | - | - | 4 | .25 | - | - | - | 67 | - | - | 9 | 6 | - | - | 22 |
| Operating or riding | - | - | - | - | - | - | - | 1 | - | - | 1 | .06 | - | - | - | - | - | - | - | 11 | - | - | 11 |
| All other | - | - | - | - | 1 | 1 | 2 | 2 | 1 | 2 | 9 | .57 | - | - | - | - | 4 | 9 | 7 | 10 | 15 | 22 | 12 |
| Squeezed between cage, car or motor, and another object: | | | | | | | | | | | | | | | | | | | | | | | |
| Pulling, pushing, or dropping | - | - | - | - | - | 1 | - | - | - | 1 | 2 | .13 | - | - | - | - | - | 11 | - | - | - | 22 | 17 |
| Operating or riding | - | - | - | - | - | 1 | - | - | - | - | 1 | .06 | - | - | - | - | - | 14 | - | - | - | - | 14 |
| All other | - | - | - | - | - | 1 | - | 1 | - | - | 2 | .13 | - | - | - | - | - | 1 | - | 4 | - | - | 3 |

TABLE B-4. - Nonfatal injuries, distribution, and average severity by part of body injured at nonmetal mines and mills in the United States, by general work location and detailed cause, 1964 - Continued

**Injuries**

| General work location and detailed cause | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total | Percentage distribution |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MILLS - Continued | | | | | | | | | | | | |
| Haulage - Continued | | | | | | | | | | | | |
| Cages, cars, or motors - Continued | | | | | | | | | | | | |
| Rerailing | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .13 |
| Falling, slipping, or jumping into or from | - | - | - | - | 1 | - | 1 | 1 | - | 1 | 4 | .25 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | | |
| Struck or run over | - | - | 2 | - | - | - | 2 | 9 | - | - | 13 | .82 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | - | - | - | 2 | - | - | - | - | 2 | .13 |
| All other | 1 | - | 5 | - | 1 | 4 | 3 | 5 | 1 | 4 | 24 | 1.52 |
| Railroad cars and locomotives | 5 | - | 9 | 1 | 2 | 5 | 5 | 7 | - | 4 | 38 | 2.41 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 5 | - | 1 | - | 2 | 5 | 1 | 1 | 15 | .95 |
| All other | 1 | - | 9 | - | 1 | 1 | 6 | 4 | 3 | 6 | 31 | 1.96 |
| Water transportation: Rope or chain on boat or barge | - | - | - | - | - | - | - | - | 1 | - | 1 | .06 |
| Miscellaneous haulage: | | | | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | 1 | - | - | - | - | - | - | - | - | - | 1 | .06 |
| Rope or cable on haulage | - | - | 1 | - | - | 3 | - | 1 | - | 1 | 6 | .38 |
| Slip or strain from moving car by hand | - | - | 20 | - | 1 | 1 | 1 | 2 | - | 2 | 27 | 1.71 |
| Riding or getting on or off conveyor belt | - | - | - | - | - | - | 1 | - | - | - | 1 | .06 |
| Flying particle | - | 3 | - | - | - | - | - | - | - | - | 3 | .19 |
| All other | - | - | 3 | 1 | - | 3 | 3 | 3 | - | 2 | 15 | .95 |
| Explosions of gas or dust: | | | | | | | | | | | | |
| Caused by electric arc | - | - | - | - | - | 1 | - | - | - | 1 | 2 | .13 |
| All other | 1 | - | - | - | 1 | - | - | - | 1 | - | 3 | .19 |
| Electricity: | | | | | | | | | | | | |
| Power or lighting circuit | - | 1 | - | - | - | - | - | - | 1 | 1 | 3 | .19 |
| Locomotive or shuttle car | - | - | - | - | - | 1 | - | - | - | - | 1 | .06 |
| Cut-out switch or junction box | - | - | - | - | - | 1 | - | - | 1 | - | 2 | .13 |
| All other | - | - | - | - | - | - | - | - | 1 | - | 1 | .06 |
| Machinery: | | | | | | | | | | | | |
| Belt conveyor | 1 | - | 2 | 1 | 10 | 23 | 2 | 2 | - | 4 | 45 | 2.85 |
| Chain, bucket, shaker, or screw conveyor | - | - | 1 | - | 1 | 8 | 2 | 3 | - | 2 | 17 | 1.08 |
| While moving loading machine or self loading head | - | - | 1 | - | - | 1 | - | - | - | - | 2 | .13 |
| Power drill; rotary or percussive (except rock bolting) | - | - | 2 | - | - | 2 | 2 | 2 | - | - | 8 | .51 |
| Power shovel, dragline, bulldozer, etc. | 1 | - | 1 | - | - | 3 | - | 1 | - | - | 6 | .38 |
| Stationary machinery | 3 | - | 2 | 1 | 6 | 32 | 6 | 5 | - | 7 | 62 | 3.92 |
| While moving machine (except chain, arc, longwall) | - | - | 3 | - | - | 2 | - | 4 | - | 2 | 11 | .70 |
| Particle set in motion by machinery (except rock bolting) | - | 10 | - | - | - | - | - | - | - | 1 | 11 | .70 |
| Mining or loading machine under repair | - | - | - | - | - | - | - | 1 | - | - | 1 | .06 |
| All other | - | - | 2 | - | 2 | 5 | 1 | 1 | - | 4 | 15 | .95 |
| Suffocation (no flame or smoldering): Foreign gas | 1 | - | 7 | - | - | - | - | - | - | - | 8 | .51 |
| Fires or suffocation from fires | - | - | 1 | - | - | - | 1 | - | - | - | 2 | .13 |
| Miscellaneous causes: | | | | | | | | | | | | |
| Flying particle from draft or wind | - | 11 | - | - | - | - | - | - | - | - | 11 | .70 |
| Acetylene or electric welding or cutting | 2 | 7 | - | - | - | - | 1 | - | - | - | 10 | .63 |
| Irritation or burn from caustic or acid | 5 | 11 | - | - | 1 | 1 | - | 2 | 2 | - | 22 | 1.39 |
| Burn from controlled fire | 4 | 2 | 1 | - | 1 | 7 | 1 | 5 | 13 | - | 34 | 2.15 |
| All other | 1 | 3 | 18 | - | 1 | 3 | 7 | 11 | 4 | 3 | 51 | 3.23 |
| Total or average, mills | 60 | 92 | 460 | 29 | 75 | 240 | 147 | 258 | 40 | 179 | 1,580 | - |
| Percentage distribution | 3.80 | 5.82 | 29.11 | 1.84 | 4.75 | 15.19 | 9.30 | 16.33 | 2.53 | 11.33 | - | - |
| Grand total | 109 | 142 | 725 | 45 | 110 | 367 | 259 | 389 | 72 | 268 | 2,486 | - |
| Percentage distribution | 4.38 | 5.71 | 29.16 | 1.81 | 4.43 | 14.76 | 10.42 | 15.65 | 2.90 | 10.78 | - | - |

**Average severity**

| General work location and detailed cause | Head, face, neck | Eye | Trunk | Hernia | Upper extremities | Hand and fingers | Lower extremities | Foot and toes | General (multiple) | Not stated | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MILLS - Continued | | | | | | | | | | | |
| Haulage - Continued | | | | | | | | | | | |
| Cages, cars, or motors - Continued | | | | | | | | | | | |
| Rerailing | - | - | 2 | - | - | - | 90 | - | - | - | 46 |
| Falling, slipping, or jumping into or from | - | - | - | - | 113 | - | 7 | 4 | - | 22 | 37 |
| Shuttle cars, transloaders, and small mobile trucks: | | | | | | | | | | | |
| Struck or run over | - | - | 6 | - | - | - | 11 | 13 | - | - | 11 |
| Squeezed between shuttle car, transloader, or small mobile truck, and other object | - | - | - | - | - | 194 | - | - | - | - | 194 |
| All other | 12 | - | 9 | - | 100 | 17 | 8 | 27 | 29 | 27 | 22 |
| Railroad cars and locomotives | 10 | - | 9 | 49 | 20 | 19 | 52 | 51 | - | 29 | 28 |
| Automobiles, gasoline or diesel trucks: | | | | | | | | | | | |
| Slip or fall from or while getting on or off | - | - | 29 | - | 1 | - | 3 | 21 | 7 | 22 | 19 |
| All other | 10 | - | 31 | - | 30 | 1 | 37 | 68 | 12 | 20 | 31 |
| Water transportation: Rope or chain on boat or barge | - | - | - | - | - | - | - | - | 9 | - | 9 |
| Miscellaneous haulage: | | | | | | | | | | | |
| Coupling or uncoupling (cars not moving) | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Rope or cable on haulage | - | - | 8 | - | - | 13 | - | 14 | - | 22 | 14 |
| Slip or strain from moving car by hand | - | - | 7 | - | 8 | 3 | 19 | 12 | - | 35 | 10 |
| Riding or getting on or off conveyor belt | - | - | - | - | - | - | 38 | - | - | - | 38 |
| Flying particle | - | 4 | - | - | - | - | - | - | - | - | 4 |
| All other | - | - | 11 | 20 | - | 30 | 13 | 6 | - | 25 | 17 |
| Explosions of gas or dust: | | | | | | | | | | | |
| Caused by electric arc | - | - | - | - | - | 96 | - | - | - | 96 | 96 |
| All other | 6,000 | - | - | - | 7 | - | - | - | 39 | - | 2,015 |
| Electricity: | | | | | | | | | | | |
| Power or lighting circuit | - | 8 | - | - | - | - | - | - | 12 | 48 | 23 |
| Locomotive or shuttle car | - | - | - | - | - | 16 | - | - | - | - | 16 |
| Cut-out switch or junction box | - | - | - | - | - | 6 | - | - | 15 | - | 11 |
| All other | - | - | - | - | - | - | - | - | 30 | - | 30 |
| Machinery: | | | | | | | | | | | |
| Belt conveyor | 7 | - | 4 | 47 | 963 | 34 | 22 | 28 | - | 110 | 245 |
| Chain, bucket, shaker, or screw conveyor | - | - | 61 | - | 16 | 74 | 3,010 | 6 | - | 110 | 408 |
| While moving loading machine or self loading head | - | - | 1 | - | - | 9 | - | - | - | - | 5 |
| Power drill; rotary or percussive (except rock bolting) | - | - | 12 | - | - | 5 | 29 | 3 | - | - | 12 |
| Power shovel, dragline, bulldozer, etc. | 17 | - | 4 | - | - | 6 | - | 5 | - | - | 7 |
| Stationary machinery | 4 | - | 5 | 60 | 34 | 225 | 113 | 177 | - | 98 | 157 |
| While moving machine (except chain, arc, longwall) | - | - | 5 | - | - | 8 | - | 14 | - | 48 | 16 |
| Particle set in motion by machinery (except rock bolting) | - | 94 | - | - | - | - | - | - | - | 48 | 90 |
| Mining or loading machine under repair | - | - | - | - | - | - | - | 14 | - | - | 14 |
| All other | - | - | 53 | - | 15 | 24 | 9 | 1 | - | 28 | 25 |
| Suffocation (no flame or smoldering): Foreign gas | 4 | - | 871 | - | - | - | - | - | - | - | 763 |
| Fires or suffocation from fires | - | - | 40 | - | - | - | 54 | - | - | - | 47 |
| Miscellaneous causes: | | | | | | | | | | | |
| Flying particle from draft or wind | - | 5 | - | - | - | - | - | - | - | - | 5 |
| Acetylene or electric welding or cutting | 9 | 2 | - | - | - | - | 13 | - | - | - | 5 |
| Irritation or burn from caustic or acid | 4 | 12 | - | - | 2 | 11 | - | 24 | 15 | - | 11 |
| Burn from controlled fire | 7 | 3 | 6 | - | 10 | 13 | 4 | 10 | 26 | - | 16 |
| All other | 3 | 11 | 14 | - | 1 | 6 | 23 | 15 | 7 | 28 | 15 |
| Total or average, mills | 108 | 35 | 36 | 53 | 145 | 53 | 76 | 21 | 19 | 34 | 47 |
| Percentage distribution | - | - | - | - | - | - | - | - | - | - | - |
| Grand total | 69 | 25 | 36 | 52 | 109 | 67 | 80 | 27 | 98 | 41 | 50 |
| Percentage distribution | - | - | - | - | - | - | - | - | - | - | - |

TABLE B-5. - Injuries, distribution, average severity by degree, and injury rates at nonmetal mines and mills in the United States, by general work location and part of body injured, 1964

| General work location and part of body injured | Injuries: Fatal | Injuries: Nonfatal: Permanent: Total | Injuries: Nonfatal: Permanent: Partial | Injuries: Nonfatal: Temporary total | Injuries: Nonfatal: Total nonfatal | Injuries: All injuries | Percentage distribution of all injuries 1/ | Average severity: Permanent partial | Average severity: Temporary total | Average severity: All injuries | Frequency rates per million man-hours: Fatal | Frequency rates per million man-hours: Nonfatal | Severity rates per million man-hours: Fatal | Severity rates per million man-hours: Nonfatal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNDERGROUND MINES | | | | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | | | | |
| Head, face, neck | 1 | - | - | 31 | 31 | 32 | 7.2 | - | 19 | 206 | 0.10 | 3.13 | 606 | 60 |
| Eye | - | - | - | 34 | 34 | 34 | 7.7 | - | 4 | 4 | - | 3.44 | - | 13 |
| Trunk | 1 | - | - | 138 | 138 | 139 | 31.5 | - | 23 | 66 | .10 | 13.95 | 606 | 324 |
| Hernia | - | - | 1 | 5 | 6 | 6 | 1.4 | 50 | 51 | 51 | - | .61 | - | 31 |
| Upper extremities | - | - | - | 17 | 17 | 17 | 3.8 | - | 33 | 33 | - | 1.72 | - | 57 |
| Hand and fingers | - | - | 7 | 55 | 62 | 62 | 14.1 | 253 | 12 | 40 | - | 6.27 | - | 248 |
| Lower extremities | - | - | 2 | 54 | 56 | 56 | 12.7 | 3,000 | 29 | 136 | - | 5.66 | - | 767 |
| Foot and toes | - | - | 2 | 75 | 77 | 77 | 17.5 | 1,275 | 20 | 53 | - | 7.78 | - | 410 |
| General (multiple) | 5 | - | - | 13 | 13 | 18 | 4.1 | - | 12 | 1,675 | .51 | 1.31 | 3,032 | 16 |
| Not stated | - | - | - | 16 | 16 | 16 | - | - | 46 | 46 | - | 1.62 | - | 75 |
| Total or average | 7 | - | 12 | 438 | 450 | 457 | - | 865 | 21 | 135 | .71 | 45.49 | 4,245 | 2,000 |
| Surface: | | | | | | | | | | | | | | |
| Head, face, neck | 1 | - | - | 3 | 3 | 4 | 5.9 | - | 7 | 1,505 | .26 | 0.79 | 1,576 | 5 |
| Eye | - | - | - | 2 | 2 | 2 | 3.0 | - | 2 | 2 | - | .53 | - | 1 |
| Trunk | - | - | - | 21 | 21 | 21 | 30.9 | - | 39 | 39 | - | 5.52 | - | 216 |
| Hernia | - | - | - | 4 | 4 | 4 | 5.9 | - | 52 | 52 | - | 1.05 | - | 55 |
| Upper extremities | - | - | - | 5 | 5 | 5 | 7.3 | - | 35 | 35 | - | 1.31 | - | 46 |
| Hand and fingers | - | - | 4 | 6 | 10 | 10 | 14.7 | 841 | 41 | 361 | - | 2.63 | - | 948 |
| Lower extremities | - | - | - | 10 | 10 | 10 | 14.7 | - | 37 | 37 | - | 2.63 | - | 96 |
| Foot and toes | - | - | - | 9 | 9 | 9 | 13.2 | - | 15 | 15 | - | 2.36 | - | 36 |
| General (multiple) | - | - | - | 3 | 3 | 3 | 4.4 | - | 19 | 19 | - | .79 | - | 15 |
| Not stated | - | - | - | 3 | 3 | 3 | - | - | 25 | 25 | - | .79 | - | 20 |
| Total or average | 1 | - | 4 | 66 | 70 | 71 | - | 841 | 32 | 162 | .26 | 18.39 | 1,576 | 1,439 |
| Total or average, underground mines | 8 | - | 16 | 504 | 520 | 528 | - | 859 | 23 | 139 | .58 | 37.96 | 3,504 | 1,844 |
| OPEN PIT MINES | | | | | | | | | | | | | | |
| Head, face, neck | - | - | - | 13 | 13 | 13 | 5.1 | - | 24 | 24 | - | .79 | - | 19 |
| Eye | - | - | - | 10 | 10 | 10 | 3.9 | - | 9 | 9 | - | .60 | - | 5 |
| Trunk | 2 | - | 1 | 87 | 88 | 90 | 35.0 | 2,400 | 28 | 187 | .12 | 5.32 | 725 | 290 |
| Hernia | - | - | - | 5 | 5 | 5 | 1.9 | - | 50 | 50 | - | .30 | - | 15 |
| Upper extremities | - | - | - | 10 | 10 | 10 | 3.9 | - | 29 | 29 | - | .60 | - | 18 |
| Hand and fingers | - | - | 3 | 43 | 46 | 46 | 17.9 | 498 | 19 | 50 | - | 2.78 | - | 140 |
| Lower extremities | - | - | - | 31 | 31 | 31 | 12.1 | - | 27 | 27 | - | 1.87 | - | 50 |
| Foot and toes | - | - | - | 34 | 34 | 34 | 13.2 | - | 19 | 19 | - | 2.05 | - | 38 |
| General (multiple) | 8 | 1 | - | 9 | 10 | 18 | 7.0 | - | 7 | 2,827 | .48 | .60 | 2,901 | 366 |
| Not stated | - | - | - | 58 | 58 | 58 | - | - | 58 | 58 | - | 3.51 | - | 203 |
| Total or average | 10 | 1 | 4 | 300 | 305 | 315 | - | 974 | 30 | 251 | .60 | 18.43 | 3,626 | 1,145 |

1/ Number of injuries for which part of body was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 441; for surface, 68; for open-pit, 257; for other surface mining, 69; and mills, 1,407.

TABLE B-5. - Injuries, distribution, average severity by degree, and injury rates at nonmetal mines and mills in the United States, by general work location and part of body injured, 1964 - Continued

| General work location and part of body injured | Injuries | | | | | | Percentage distribution of all injuries 1/ | Average severity | | | Frequency rates per million man-hours | | Severity rates per million man-hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | | Permanent partial | Temporary total | All injuries | Fatal | Nonfatal | Fatal | Nonfatal |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | |
| OTHER SURFACE MINING | | | | | | | | | | | | | | |
| Head, face, neck | - | - | - | 2 | 2 | 2 | 2.9 | - | 24 | 24 | - | 0.35 | - | 8 |
| Eye | - | - | - | 4 | 4 | 4 | 5.8 | - | 11 | 11 | - | .70 | - | 8 |
| Trunk | - | - | - | 18 | 18 | 18 | 26.1 | - | 26 | 26 | - | 3.14 | - | 82 |
| Hernia | - | - | - | 1 | 1 | 1 | 1.5 | - | 49 | 49 | - | .17 | - | 9 |
| Upper extremities | - | - | - | 3 | 3 | 3 | 4.4 | - | 31 | 31 | - | .52 | - | 16 |
| Hand and fingers | - | - | 2 | 7 | 9 | 9 | 13.0 | 1,550 | 26 | 365 | - | 1.57 | - | 573 |
| Lower extremities | - | - | - | 15 | 15 | 15 | 21.7 | - | 40 | 40 | - | 2.62 | - | 104 |
| Foot and toes | - | - | - | 11 | 11 | 11 | 15.9 | - | 38 | 38 | - | 1.92 | - | 73 |
| General (multiple) | - | - | - | 6 | 6 | 6 | 8.7 | - | 6 | 6 | - | 1.05 | - | 7 |
| Not stated | - | - | - | 12 | 12 | 12 | - | - | 54 | 54 | - | 2.09 | - | 113 |
| Total or average | - | - | 2 | 79 | 81 | 81 | - | 1,550 | 33 | 70 | - | 14.13 | - | 992 |
| Total or average, mining | 18 | 1 | 22 | 883 | 906 | 924 | - | 942 | 26 | 171 | 0.50 | 25.18 | 3,002 | 1,387 |
| MILLS | | | | | | | | | | | | | | |
| Head, face, neck | - | 1 | - | 59 | 60 | 60 | 4.3 | - | 8 | 108 | - | .84 | - | 91 |
| Eye | - | - | 3 | 89 | 92 | 92 | 6.5 | 921 | 6 | 35 | - | 1.29 | - | 46 |
| Trunk | 1 | 1 | 2 | 457 | 460 | 461 | 32.8 | 1,050 | 18 | 49 | .01 | 6.44 | 84 | 231 |
| Hernia | - | - | 1 | 28 | 29 | 29 | 2.1 | 50 | 53 | 53 | - | .41 | - | 21 |
| Upper extremities | - | - | 2 | 73 | 75 | 75 | 5.3 | 4,500 | 26 | 145 | - | 1.05 | - | 153 |
| Hand and fingers | - | - | 25 | 215 | 240 | 240 | 17.1 | 395 | 13 | 53 | - | 3.36 | - | 179 |
| Lower extremities | - | 1 | 2 | 144 | 147 | 147 | 10.4 | 450 | 30 | 76 | - | 2.06 | - | 157 |
| Foot and toes | - | - | 3 | 255 | 258 | 258 | 18.3 | 330 | 17 | 21 | - | 3.61 | - | 74 |
| General (multiple) | 5 | - | - | 40 | 40 | 45 | 3.2 | - | 18 | 683 | .07 | .56 | 420 | 11 |
| Not stated | - | - | - | 179 | 179 | 179 | - | - | 34 | 34 | - | 2.50 | - | 85 |
| Total or average, mills | 6 | 3 | 38 | 1,539 | 1,580 | 1,586 | - | 676 | 20 | 70 | .08 | 22.11 | 504 | 1,046 |
| Grand total or average | 24 | 4 | 60 | 2,422 | 2,486 | 2,510 | - | 773 | 22 | 107 | .22 | 23.14 | 1,340 | 1,160 |

1/ Number of injuries for which part of body was not ststed is excluded in calculating percentages. Therefore, 100 percent for underground is 441; for surface, 68; for open-pit, 257; for other surface mining, 69; and mills, 1,407.

TABLE B-6. - Injuries, distribution, average severity by degree and injury rates at nonmetal mines and mills in the United States, by general work location and nature of injury, 1964

| General work location and nature of injury | Injuries | | | | | | Percentage distribution of all injuries 1/ | Average severity | | | Frequency rates per million man-hours | | Severity rates per million man-hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | | Permanent partial | Temporary total | All injuries | Fatal | Nonfatal | Fatal | Nonfatal |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | |
| UNDERGROUND MINES | | | | | | | | | | | | | | |
| Underground (including shaft and slope): | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 9 | - | 9 | 9 | 2.0 | 858 | - | 858 | - | 0.91 | - | 781 |
| Asphyxiation | - | - | - | 2 | 2 | 2 | .5 | - | 7 | 7 | - | .20 | - | 1 |
| Bruise or contusion | 2 | - | 1 | 126 | 127 | 129 | 29.4 | 2,400 | 13 | 125 | 0.20 | 12.84 | 1,213 | 411 |
| Burn or scald (except chemical) | - | - | - | 9 | 9 | 9 | 2.0 | - | 14 | 14 | - | .91 | - | 13 |
| Chemical burn | - | - | - | 2 | 2 | 2 | .5 | - | 5 | 5 | - | .20 | - | 1 |
| Radiation and radiating substances (includes welder's flash) | - | - | - | 3 | 3 | 3 | .7 | - | 2 | 2 | - | .30 | - | 1 |
| Cut, laceration, or puncture | - | - | - | 48 | 48 | 48 | 10.9 | - | 15 | 15 | - | 4.85 | - | 70 |
| Electric shock | 2 | - | - | - | - | 2 | .5 | - | - | 6,000 | .20 | - | 1,213 | - |
| Foreign body in eye | - | - | - | 23 | 23 | 23 | 5.2 | - | 4 | 4 | - | 2.32 | - | 9 |
| Fracture | 1 | - | 1 | 62 | 63 | 64 | 14.6 | 200 | 57 | 152 | .10 | 6.37 | 606 | 375 |
| Hernia | - | - | 1 | 5 | 6 | 6 | 1.3 | 50 | 51 | 51 | - | .61 | - | 31 |
| Poisoning (systemic) | - | - | - | 2 | 2 | 2 | .5 | - | 4 | 4 | - | .20 | - | 1 |
| Strain, sprain, dislocation | - | - | - | 126 | 126 | 126 | 28.7 | - | 15 | 15 | - | 12.74 | - | 188 |
| All other pneumoconiosis, n.e.c. | - | - | - | 2 | 2 | 2 | .5 | - | 86 | 86 | - | .20 | - | 17 |
| Other, n.e.c. | - | - | - | 12 | 12 | 12 | 2.7 | - | 22 | 22 | - | 1.21 | - | 27 |
| Not stated | 2 | - | - | 16 | 16 | 18 | - | - | 46 | 708 | .20 | 1.62 | 1,213 | 75 |
| Total or average | 7 | - | 12 | 438 | 450 | 457 | - | 865 | 21 | 135 | .71 | 45.49 | 4,245 | 2,000 |
| Surface: | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 4 | - | 4 | 4 | 5.9 | 841 | - | 841 | - | 1.05 | - | 884 |
| Bruise or contusion | - | - | - | 13 | 13 | 13 | 19.1 | - | 13 | 13 | - | 3.42 | - | 45 |
| Burn or scald (except chemical) | - | - | - | 3 | 3 | 3 | 4.4 | - | 15 | 15 | - | .79 | - | 12 |
| Cut, laceration, or puncture | - | - | - | 5 | 5 | 5 | 7.4 | - | 5 | 5 | - | 1.31 | - | 7 |
| Foreign body in eye | - | - | - | 1 | 1 | 1 | 1.5 | - | 1 | 1 | - | .26 | - | (2/) |
| Fracture | 1 | - | - | 11 | 11 | 12 | 17.6 | - | 65 | 559 | .26 | 2.89 | 1,576 | 187 |
| Hernia | - | - | - | 4 | 4 | 4 | 5.9 | - | 52 | 52 | - | 1.05 | - | 55 |
| Strain, sprain, dislocation | - | - | - | 26 | 26 | 26 | 38.2 | - | 33 | 33 | - | 6.83 | - | 229 |
| Not stated | - | - | - | 3 | 3 | 3 | - | - | 25 | 25 | - | .79 | - | 20 |
| Total or average | 1 | - | 4 | 66 | 70 | 71 | - | 841 | 32 | 162 | .26 | 18.39 | 1,576 | 1,439 |
| Total or average, underground mines | 8 | - | 16 | 504 | 520 | 528 | - | 859 | 23 | 139 | .58 | 37.96 | 3,504 | 1,844 |
| OPEN PIT MINES | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 1 | - | 1 | 1 | .4 | 75 | - | 75 | - | .06 | - | 5 |
| Bruise or contusion | 6 | 1 | - | 62 | 63 | 69 | 28.0 | - | 13 | 620 | .36 | 3.75 | 2,176 | 410 |
| Burn or scald (except chemical) | - | - | 1 | 5 | 6 | 6 | 2.4 | 1,200 | 11 | 209 | - | .36 | - | 76 |
| Chemical burn | - | - | - | 1 | 1 | 1 | .4 | - | 6 | 6 | - | .06 | - | (2/) |
| Radiation and radiating substances (includes welder's flash) | - | - | - | 1 | 1 | 1 | .4 | - | 1 | 1 | - | .06 | - | (2/) |
| Cut, laceration, or puncture | - | - | 2 | 29 | 31 | 31 | 12.6 | 1,310 | 17 | 101 | - | 1.87 | - | 188 |
| Foreign body in eye | - | - | - | 6 | 6 | 6 | 2.4 | - | 12 | 12 | - | .36 | - | 4 |
| Fracture | - | - | - | 39 | 39 | 39 | 15.8 | - | 51 | 51 | - | 2.36 | - | 120 |
| Heat exhaustion, sunstroke | - | - | - | 2 | 2 | 2 | .8 | - | 6 | 6 | - | .12 | - | 1 |
| Hernia | - | - | - | 5 | 5 | 5 | 2.0 | - | 50 | 50 | - | .30 | - | 15 |
| Poisoning (systemic) | - | - | - | 1 | 1 | 1 | .4 | - | 31 | 31 | - | .06 | - | 2 |
| Strain, sprain, dislocation | - | - | - | 80 | 80 | 80 | 32.4 | - | 19 | 19 | - | 4.83 | - | 92 |
| All other pneumoconiosis, n.e.c. | - | - | - | 1 | 1 | 1 | .4 | - | 23 | 23 | - | .06 | - | 1 |
| Other, n.e.c. | 1 | - | - | 3 | 3 | 4 | 1.6 | - | 60 | 1,545 | .06 | .18 | 363 | 11 |
| Not stated | 3 | - | - | 65 | 65 | 68 | - | - | 56 | 318 | .18 | 3.93 | 1,088 | 219 |
| Total or average | 10 | 1 | 4 | 300 | 305 | 315 | - | 974 | 30 | 251 | .60 | 18.43 | 3,626 | 1,145 |

1/ Number of injuries for which nature of injury was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 439; for surface, 68; for open-pit, 247; for other surface mining, 69; and for mills, 1,400.
2/ Less than 0.5.

TABLE B-6. - Injuries, distribution, average severity by degree and injury rates at nonmetal mines and mills in the United States, by general work location and nature of injury, 1964 - Continued

| General work location and nature of injury | Injuries | | | | | | Percentage distribution of all injuries 1/ | Average severity | | | Frequency rates per million man-hours | | Severity rates per million man-hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | | | | All injuries | | Permanent partial | Temporary total | All injuries | Fatal | Nonfatal | Fatal | Nonfatal |
| | | Permanent | | Temporary total | Total nonfatal | | | | | | | | | |
| | | Total | Partial | | | | | | | | | | | |
| OTHER SURFACE MINING | | | | | | | | | | | | | | |
| Amputation and enucleation | - | - | 2 | - | 2 | 2 | 2.9 | 1,550 | - | 1,550 | - | 0.35 | - | 541 |
| Asphyxiation | - | - | - | 1 | 1 | 1 | 1.4 | - | 1 | 1 | - | .17 | - | (2/) |
| Bruise or contusion | - | - | - | 18 | 18 | 18 | 26.1 | - | 21 | 21 | - | 3.14 | - | 65 |
| Burn or scald (except chemical) | - | - | - | 1 | 1 | 1 | 1.4 | - | 1 | 1 | - | .17 | - | (2/) |
| Chemical burn | - | - | - | 4 | 4 | 4 | 5.8 | - | 6 | 6 | - | .70 | - | 4 |
| Radiation and radiating substances (includes welder's flash) | - | - | - | 1 | 1 | 1 | 1.4 | - | 1 | 1 | - | .17 | - | (2/) |
| Cut, laceration, or puncture | - | - | - | 6 | 6 | 6 | 8.7 | - | 40 | 40 | - | 1.05 | - | 42 |
| Dermatitis | - | - | - | 1 | 1 | 1 | 1.5 | - | 10 | 10 | - | .17 | - | 2 |
| Foreign body in eye | - | - | - | 2 | 2 | 2 | 2.9 | - | 6 | 6 | - | .35 | - | 2 |
| Fracture | - | - | - | 10 | 10 | 10 | 14.5 | - | 76 | 76 | - | 1.74 | - | 133 |
| Hernia | - | - | - | 1 | 1 | 1 | 1.5 | - | 49 | 49 | - | .17 | - | 9 |
| Strain, sprain, dislocation | - | - | - | 22 | 22 | 22 | 31.9 | - | 21 | 21 | - | 3.84 | - | 82 |
| Not stated | - | - | - | 12 | 12 | 12 | - | - | 54 | 54 | - | 2.09 | - | 113 |
| Total or average | - | - | 2 | 79 | 81 | 81 | - | 1,550 | 33 | 70 | - | 14.13 | - | 992 |
| Total or average, mining | 18 | 1 | 22 | 883 | 906 | 924 | - | 942 | 26 | 171 | 0.50 | 25.18 | 3,002 | 1,387 |
| MILLS | | | | | | | | | | | | | | |
| Amputation and enucleation | - | 1 | 21 | - | 22 | 22 | 1.6 | 761 | - | 999 | - | .31 | - | 308 |
| Asphyxiation | 1 | - | - | 3 | 3 | 4 | .3 | - | 4 | 1,503 | .01 | .04 | 84 | (2/) |
| Bruise or contusion | 1 | 1 | 3 | 319 | 323 | 324 | 23.1 | 750 | 11 | 54 | .01 | 4.52 | 84 | 160 |
| Burn or scald (except chemical) | 1 | - | - | 47 | 47 | 48 | 3.4 | - | 19 | 143 | .01 | .66 | 84 | 12 |
| Chemical burn | - | - | - | 22 | 22 | 22 | 1.6 | - | 11 | 11 | - | .31 | - | 4 |
| Radiation and radiating substances (includes welder's flash) | - | - | - | 5 | 5 | 5 | .4 | - | 5 | 5 | - | .07 | - | (2/) |
| Cut, laceration, or puncture | - | - | 1 | 165 | 166 | 166 | 11.8 | 120 | 11 | 12 | - | 2.32 | - | 27 |
| Dermatitis | - | - | - | 4 | 4 | 4 | .3 | - | 11 | 11 | - | .06 | - | 1 |
| Electric shock | 2 | - | - | 2 | 2 | 4 | .3 | - | 9 | 3,005 | .03 | .03 | 168 | (2/) |
| Foreign body in eye | - | - | 3 | 53 | 56 | 56 | 4.0 | 921 | 4 | 53 | - | .78 | - | 42 |
| Fracture | - | - | 5 | 185 | 190 | 190 | 13.6 | 302 | 44 | 51 | - | 2.66 | - | 135 |
| Heat exhaustion, sunstroke | - | - | - | 9 | 9 | 9 | .6 | - | 12 | 12 | - | .13 | - | 2 |
| Hernia | - | - | 1 | 28 | 29 | 29 | 2.1 | 50 | 53 | 53 | - | .41 | - | 21 |
| Poisoning (systemic) | - | - | - | 3 | 3 | 3 | .2 | - | 22 | 22 | - | .04 | - | 1 |
| Strain, sprain, dislocation | - | - | 1 | 492 | 493 | 493 | 35.2 | 1,200 | 17 | 19 | - | 6.90 | - | 132 |
| Other, n.e.c. | - | - | 3 | 18 | 21 | 21 | 1.5 | 600 | 19 | 102 | - | .29 | - | 30 |
| Not stated | 1 | 1 | - | 184 | 185 | 186 | - | - | 33 | 97 | .01 | 2.59 | 84 | 170 |
| Total or average | 6 | 3 | 38 | 1,539 | 1,580 | 1,586 | - | 676 | 20 | 70 | .08 | 22.11 | 504 | 1,046 |
| Grand total or average | 24 | 4 | 60 | 2,422 | 2,486 | 2,510 | - | 773 | 22 | 107 | .22 | 23.14 | 1,340 | 1,160 |

1/ Number of injuries for which nature of injury was not stated is excluded in calculating percentages. Therefore, 100 percent for underground is 439; for surface, 68; for open-pit, 247; for other surface mining, 69; and for mills, 1,400.
2/ Less than 0.5.

TABLE B-7. - Injury experience and employment data on nonmetal mines and mills in the United States, by general work location and employment size group, 1964

| General work location and employment size group | Injuries | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Active operations | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | | | | | |
| Underground mines (includes surface work): | | | | | | | | | | | | | | |
| 1-4 | 1 | 8 | 9 | 5.69 | 45.56 | 51.25 | 34,168 | 1,811 | 35,978 | 66 | 126 | 175 | 22,016 | 175,605 |
| 5-9 | - | 31 | 31 | - | 52.52 | 52.52 | - | 2,197 | 2,197 | 45 | 329 | 221 | 72,655 | 590,261 |
| 10-19 | - | 62 | 62 | - | 59.83 | 59.83 | - | 1,099 | 1,099 | 40 | 557 | 235 | 130,804 | 1,036,272 |
| 20-49 | - | 66 | 66 | - | 41.18 | 41.18 | - | 3,179 | 3,179 | 26 | 797 | 252 | 200,529 | 1,602,569 |
| 50-99 | 2 | 178 | 180 | .51 | 45.38 | 45.89 | 3,059 | 1,877 | 4,936 | 26 | 1,832 | 268 | 490,991 | 3,922,434 |
| 100-249 | 1 | 61 | 62 | .48 | 28.98 | 29.46 | 2,851 | 938 | 3,789 | 6 | 908 | 274 | 249,175 | 2,104,717 |
| 250 or more | 4 | 114 | 118 | .94 | 26.71 | 27.65 | 5,624 | 1,893 | 7,517 | 4 | 1,487 | 359 | 533,451 | 4,267,607 |
| Total or average | 8 | 520 | 528 | .58 | 37.96 | 38.54 | 3,504 | 1,844 | 5,348 | 213 | 6,036 | 282 | 1,699,621 | 13,699,465 |
| Open pit mines: | | | | | | | | | | | | | | |
| 1-4 | 6 | 45 | 51 | 1.78 | 13.32 | 15.09 | 10,655 | 544 | 11,200 | 1,375 | 2,515 | 165 | 416,010 | 3,378,621 |
| 5-9 | - | 82 | 82 | - | 33.09 | 33.09 | - | 1,239 | 1,239 | 251 | 1,538 | 199 | 305,894 | 2,478,094 |
| 10-19 | 1 | 46 | 47 | .39 | 18.11 | 18.51 | 2,362 | 516 | 2,879 | 102 | 1,289 | 243 | 313,220 | 2,539,757 |
| 20-49 | 2 | 74 | 76 | .57 | 21.02 | 21.59 | 3,409 | 2,427 | 5,836 | 60 | 1,698 | 255 | 432,281 | 3,520,090 |
| 50-99 | 1 | 43 | 44 | .29 | 12.53 | 12.82 | 1,749 | 386 | 2,135 | 22 | 1,441 | 295 | 424,781 | 3,431,182 |
| 100-249 | - | 15 | 15 | - | 12.52 | 12.52 | - | 2,387 | 2,387 | 5 | 458 | 327 | 149,806 | 1,198,452 |
| 250 or more | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total or average | 10 | 305 | 315 | .60 | 18.43 | 19.04 | 3,626 | 1,145 | 4,772 | 1,815 | 8,939 | 228 | 2,041,992 | 16,546,196 |
| Other surface mining: | | | | | | | | | | | | | | |
| 1-4 | - | 3 | 3 | - | 10.12 | 10.12 | - | 425 | 425 | 115 | 163 | 228 | 37,178 | 296,354 |
| 5-9 | - | 12 | 12 | - | 38.54 | 38.54 | - | 877 | 877 | 21 | 140 | 273 | 38,278 | 311,332 |
| 10-19 | - | 8 | 8 | - | 25.20 | 25.20 | - | 10,280 | 10,280 | 10 | 134 | 296 | 39,687 | 317,499 |
| 20-49 | - | 12 | 12 | - | 28.40 | 28.40 | - | 1,559 | 1,559 | 5 | 178 | 297 | 52,824 | 422,589 |
| 50-99 | - | 13 | 13 | - | 6.11 | 6.11 | - | 74 | 74 | 8 | 629 | 362 | 227,568 | 2,128,625 |
| 100-249 | - | 10 | 10 | - | 18.07 | 18.07 | - | 305 | 305 | 1 | 283 | 244 | 69,178 | 553,426 |
| 250 or more | - | 23 | 23 | - | 13.52 | 13.52 | - | 610 | 610 | 2 | 585 | 365 | 213,657 | 1,701,259 |
| Total or average | - | 81 | 81 | - | 14.13 | 14.13 | - | 992 | 992 | 162 | 2,112 | 321 | 678,370 | 5,731,084 |
| Total or average, mining | 18 | 906 | 924 | .50 | 25.18 | 25.68 | 3,002 | 1,387 | 4,389 | 2,190 | 17,087 | 259 | 4,419,983 | 35,976,745 |
| Mills: | | | | | | | | | | | | | | |
| 1-4 | - | 19 | 19 | - | 20.60 | 20.60 | - | 632 | 632 | 220 | 501 | 228 | 114,384 | 922,314 |
| 5-9 | - | 50 | 50 | - | 33.04 | 33.04 | - | 520 | 520 | 116 | 779 | 238 | 185,015 | 1,513,506 |
| 10-19 | 2 | 163 | 165 | .39 | 31.52 | 31.91 | 2,321 | 2,165 | 4,486 | 180 | 2,490 | 262 | 652,179 | 5,171,160 |
| 20-49 | 2 | 497 | 499 | .13 | 32.32 | 32.45 | 780 | 2,175 | 2,955 | 228 | 7,263 | 261 | 1,898,740 | 15,375,186 |
| 50-99 | 1 | 357 | 358 | .07 | 25.39 | 25.46 | 427 | 754 | 1,181 | 93 | 6,320 | 277 | 1,749,597 | 14,058,799 |
| 100-249 | - | 319 | 319 | - | 15.98 | 15.98 | - | 61 | 61 | 58 | 8,898 | 282 | 2,506,080 | 19,964,438 |
| 250 or more | 1 | 175 | 176 | .07 | 12.11 | 12.18 | 415 | 412 | 827 | 16 | 5,716 | 316 | 1,807,779 | 14,455,721 |
| Total or average, mills | 6 | 1,580 | 1,586 | .08 | 22.11 | 22.19 | 504 | 1,046 | 1,550 | 911 | 31,967 | 279 | 8,913,774 | 71,461,124 |
| Grand total or average | 24 | 2,486 | 2,510 | .22 | 23.14 | 23.36 | 1,340 | 1,160 | 2,501 | 3,101 | 49,054 | 272 | 13,333,757 | 107,437,869 |

TABLE B-8. - Injuries by degree at nonmetal mines and mills in the United States, by State 1/, 1964

| State | Injuries | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | At mines | | | | | | At mills | | | | | |
| | Fatal | Nonfatal | | | | All injuries | Fatal | Nonfatal | | | | All injuries |
| | | Permanent | | Temporary total | Total nonfatal | | | Permanent | | Temporary total | Total nonfatal | |
| | | Total | Partial | | | | | Total | Partial | | | |
| Alabama--------- | - | - | - | 10 | 10 | 10 | - | - | - | 26 | 26 | 26 |
| Arizona--------- | - | - | - | 6 | 6 | 6 | - | - | - | 4 | 4 | 4 |
| Arkansas-------- | - | - | - | 30 | 30 | 30 | - | - | 1 | 47 | 48 | 48 |
| California------ | 2 | - | - | 62 | 62 | 64 | 1 | - | 2 | 109 | 111 | 112 |
| Colorado-------- | - | - | 2 | 10 | 12 | 12 | - | - | - | 3 | 3 | 3 |
| Connecticut----- | - | - | - | 1 | 1 | 1 | - | - | - | 3 | 3 | 3 |
| Florida--------- | 1 | 1 | 1 | 32 | 34 | 35 | - | - | - | 39 | 39 | 39 |
| Georgia--------- | 3 | - | 2 | 40 | 42 | 45 | - | - | 2 | 177 | 179 | 179 |
| Hawaii---------- | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| Idaho----------- | - | - | - | 12 | 12 | 12 | - | - | 1 | 14 | 15 | 15 |
| Illinois-------- | - | - | 1 | 16 | 17 | 17 | 1 | - | 2 | 81 | 83 | 84 |
| Indiana--------- | - | - | - | 1 | 1 | 1 | 1 | - | 2 | 17 | 19 | 20 |
| Iowa------------ | - | - | - | 10 | 10 | 10 | - | 1 | 1 | 48 | 50 | 50 |
| Kansas---------- | - | - | 1 | 8 | 9 | 9 | - | - | 1 | 38 | 39 | 39 |
| Kentucky-------- | 1 | - | - | 27 | 27 | 28 | - | - | - | 10 | 10 | 10 |
| Louisiana------- | - | - | 1 | 42 | 43 | 43 | - | - | 1 | 77 | 78 | 78 |
| Maine----------- | - | - | - | - | - | - | - | - | - | 5 | 5 | 5 |
| Maryland-------- | - | - | - | 2 | 2 | 2 | - | - | 1 | 19 | 20 | 20 |
| Massachusetts--- | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - |
| Michigan-------- | - | - | - | 10 | 10 | 10 | - | - | 2 | 42 | 44 | 44 |
| Minnesota------- | 1 | - | - | - | - | 1 | - | - | 1 | 27 | 28 | 28 |
| Mississippi----- | - | - | - | 1 | 1 | 1 | - | - | 2 | 33 | 35 | 35 |
| Missouri-------- | 1 | - | - | 23 | 23 | 24 | - | - | 1 | 31 | 32 | 32 |
| Montana--------- | 1 | - | - | 22 | 22 | 23 | - | - | 1 | 17 | 18 | 18 |
| Nebraska-------- | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada---------- | - | - | - | 6 | 6 | 6 | - | - | 3 | 31 | 34 | 34 |
| New Hampshire--- | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - |
| New Jersey------ | 1 | - | - | 8 | 8 | 9 | - | - | 1 | 10 | 11 | 11 |
| New Mexico------ | 4 | - | 6 | 164 | 170 | 174 | 1 | - | - | 53 | 53 | 54 |
| New York-------- | 1 | - | 4 | 59 | 63 | 64 | - | - | 1 | 77 | 78 | 78 |
| North Carolina-- | 1 | - | - | 14 | 14 | 15 | - | - | 3 | 63 | 66 | 66 |
| North Dakota---- | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| Ohio------------ | - | - | 1 | 32 | 33 | 33 | - | - | 3 | 77 | 80 | 80 |
| Oklahoma-------- | - | - | - | 3 | 3 | 3 | - | - | - | 11 | 11 | 11 |
| Oregon---------- | - | - | - | 1 | 1 | 1 | - | - | - | 6 | 6 | 6 |
| Pennsylvania---- | - | - | 1 | 30 | 31 | 31 | 1 | - | - | 94 | 94 | 95 |
| South Carolina-- | - | - | - | 7 | 7 | 7 | - | - | 1 | 33 | 34 | 34 |
| South Dakota---- | - | - | - | 5 | 5 | 5 | - | - | - | 4 | 4 | 4 |
| Tennessee------- | - | - | 1 | 21 | 22 | 22 | - | - | 1 | 9 | 10 | 10 |
| Texas----------- | 1 | - | - | 63 | 63 | 64 | - | 2 | 2 | 86 | 90 | 90 |
| Utah------------ | - | - | - | 73 | 73 | 73 | 1 | - | - | 11 | 11 | 12 |
| Vermont--------- | - | - | - | 8 | 8 | 8 | - | - | - | 9 | 9 | 9 |
| Virginia-------- | - | - | - | 9 | 9 | 9 | - | - | 1 | 35 | 36 | 36 |
| Washington------ | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - |
| West Virginia--- | - | - | - | 6 | 6 | 6 | - | - | - | 30 | 30 | 30 |
| Wisconsin------- | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| Wyoming--------- | - | - | 1 | 6 | 7 | 7 | - | - | 1 | 29 | 30 | 30 |
| Total------ | 18 | 1 | 22 | 883 | 906 | 924 | 6 | 3 | 38 | 1,539 | 1,580 | 1,586 |

1/ No injuries were reported at nonmetal mines and mills for States not listed.

TABLE B-9. - Fatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1964

| State | Underground | | | | | Shaft and slope | | Total, underground plus total, shaft and slope | Surface | | Total, underground mines | Open pit | | | | | Total, mining activities | Mills | | | | | | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Falls of roof or back | Sliding or falling material or objects | Haulage | Electricity | Total, underground | Slips or falls of persons | Total, shaft and slope | | Haulage | Total, surface | | Falls of face or side | Handling material | Haulage | Machinery | Total, open pit | | Slips or falls of persons | Explosions of gas or dust | Electricity | Machinery | Suffocation (no flame or smoldering) | Total, mills | |
| California | - | - | 1 | - | 1 | 1 | 1 | 2 | - | - | 2 | - | - | - | - | - | 2 | 1 | - | - | - | - | 1 | 3 |
| Florida | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | - | - | - | 1 |
| Georgia | - | - | - | - | - | - | - | - | - | - | - | 2 | 1 | - | - | 3 | 3 | - | - | - | - | - | - | 3 |
| Illinois | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 1 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 1 |
| Kentucky | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | - | - | - | 1 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - | 1 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | - | - | - | 1 |
| Montana | - | - | 1 | - | 1 | - | - | 1 | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - | 1 |
| New Mexico | 1 | 1 | - | 2 | 4 | - | - | 4 | - | - | 4 | - | - | - | - | - | 4 | - | - | 1 | - | - | 1 | 5 |
| New York | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | - | - | - | 1 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | - | - | - | 1 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| Total | 1 | 1 | 2 | 2 | 6 | 1 | 1 | 7 | 1 | 1 | 8 | 2 | 1 | 5 | 2 | 10 | 18 | 1 | 1 | 2 | 1 | 1 | 6 | 24 |

1/ No fatal injuries were reported at nonmetal mines and mills for States not listed.

TABLE B-10. - Nonfatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1964

**Underground**

| State | Falls of roof or back | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosives | Electricity | Machinery | Suffocation (no flame or smoldering) | Miscellaneous causes | Total, underground |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| Arizona | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Arkansas | - | 7 | 2 | 3 | 7 | 1 | 1 | - | - | 1 | - | - | 1 | 4 | 27 |
| California | 5 | - | - | 3 | 2 | - | 3 | - | 4 | - | - | 4 | - | 1 | 22 |
| Colorado | 1 | - | 3 | - | 2 | 1 | - | - | 2 | - | - | - | - | 1 | 10 |
| Connecticut | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Florida | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Georgia | 1 | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | 3 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Illinois | 2 | 1 | - | 1 | - | 1 | - | - | 2 | - | - | 4 | - | - | 11 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | - | 1 | 1 | 1 | - | - | - | - | - | 1 | - | 1 | 5 |
| Kentucky | 6 | 2 | 1 | 1 | 4 | 2 | - | - | 4 | - | - | 2 | 2 | - | 24 |
| Louisiana | 2 | 1 | 1 | - | 4 | 2 | - | 1 | 2 | - | - | 4 | 2 | - | 19 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | 1 | 2 | - | - | - | 1 | - | - | - | - | - | 4 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Montana | 4 | - | 2 | 4 | 3 | 1 | - | - | 1 | 2 | - | 1 | - | - | 18 |
| Nevada | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Mexico | 2 | 2 | 3 | 8 | 39 | 11 | 3 | 2 | 37 | 2 | 10 | 25 | - | 5 | 149 |
| New York | 2 | 1 | 3 | 3 | 8 | 2 | 3 | - | 8 | - | - | 6 | - | 2 | 38 |
| North Carolina | - | - | - | - | - | - | - | - | 2 | 1 | - | - | - | - | 3 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ohio | 4 | - | 2 | 4 | 6 | 3 | - | - | 1 | - | 1 | 1 | - | - | 22 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pennsylvania | 1 | - | - | 1 | 4 | - | 2 | - | 3 | - | - | 1 | - | - | 12 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| South Dakota | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Utah | 3 | 12 | 4 | 8 | 14 | 5 | - | - | 11 | - | - | 4 | - | - | 61 |
| Vermont | 1 | - | 1 | - | 1 | 1 | - | - | - | - | - | 2 | - | - | 6 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | 1 | - | 1 | - | - | - | 2 | - | - | - | - | 1 | 5 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Wyoming | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | 2 |
| Total | 35 | 28 | 24 | 39 | 102 | 32 | 12 | 3 | 82 | 6 | 11 | 56 | 5 | 15 | 450 |

**Surface**

| State | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Haulage | Machinery | Miscellaneous causes | Total, surface | Total, underground mines |
|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | - | - | 1 |
| Arizona | - | - | 1 | - | - | - | - | - | 1 | 3 |
| Arkansas | - | - | - | - | - | - | - | - | - | 27 |
| California | - | - | - | - | - | - | - | - | - | 22 |
| Colorado | - | - | - | - | - | - | - | - | - | 10 |
| Connecticut | - | - | - | - | - | - | - | - | - | 1 |
| Florida | - | - | - | - | - | - | - | - | - | - |
| Georgia | - | - | - | - | - | - | - | - | - | 3 |
| Hawaii | - | - | - | - | - | - | - | - | - | - |
| Idaho | - | - | - | - | - | - | - | - | - | - |
| Illinois | - | - | - | - | - | - | - | - | - | 11 |
| Indiana | - | - | - | - | - | - | - | - | - | - |
| Iowa | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | - | - | - | 1 | - | - | 1 | 6 |
| Kentucky | - | - | - | - | - | - | - | - | - | 24 |
| Louisiana | - | 4 | 3 | 2 | 1 | 1 | 1 | - | 12 | 31 |
| Maine | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - |
| Massachusetts | - | - | - | - | - | - | - | - | - | - |
| Michigan | - | - | 2 | - | - | 1 | 1 | - | 4 | 8 |
| Minnesota | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - |
| Missouri | - | - | - | - | - | - | - | - | - | - |
| Montana | - | - | - | - | - | - | - | - | - | 18 |
| Nevada | - | - | - | - | - | - | - | - | - | 1 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | - | - | - | - | - | - | - |
| New Mexico | 1 | 4 | 4 | 2 | 1 | 2 | 4 | 1 | 19 | 168 |
| New York | - | 1 | 6 | - | - | 5 | 4 | 2 | 18 | 56 |
| North Carolina | - | - | - | - | - | - | - | - | - | 3 |
| North Dakota | - | - | - | - | - | - | - | - | - | - |
| Ohio | - | 1 | 1 | 1 | - | - | - | - | 3 | 25 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - |
| Oregon | - | - | - | - | - | - | - | - | - | - |
| Pennsylvania | - | - | 1 | - | - | - | - | 1 | 2 | 14 |
| South Carolina | - | - | - | - | - | - | - | - | - | - |
| South Dakota | - | - | - | 1 | - | - | - | - | 1 | 3 |
| Tennessee | - | - | - | - | - | - | - | - | - | - |
| Texas | - | 1 | 1 | - | - | 1 | - | - | 3 | 4 |
| Utah | - | - | 1 | - | - | 1 | 1 | - | 3 | 64 |
| Vermont | - | 1 | - | - | - | - | 1 | - | 2 | 8 |
| Virginia | - | - | - | - | - | - | - | - | - | 1 |
| Washington | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | - | 5 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - |
| Wyoming | - | - | 1 | - | - | - | - | - | 1 | 3 |
| Total | 1 | 12 | 21 | 6 | 2 | 12 | 12 | 4 | 70 | 520 |

**Open pit**

| State | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Electricity | Machinery | Miscellaneous causes | Pneumoconiosis | Total, open pit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | 4 | 2 | 1 | - | - | - | 1 | 1 | - | - | 9 |
| Arizona | 1 | - | 1 | - | - | - | - | - | - | 1 | - | - | 3 |
| Arkansas | - | - | 1 | 1 | - | - | - | - | - | 1 | - | - | 3 |
| California | 1 | 1 | 3 | 10 | - | - | - | 4 | - | 1 | - | - | 20 |
| Colorado | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | 1 | 7 | 3 | - | 1 | 1 | 8 | - | 7 | 3 | - | 31 |
| Georgia | - | 2 | 14 | 8 | 2 | 1 | 1 | 3 | 1 | 3 | 3 | 1 | 39 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Idaho | - | - | 1 | 1 | 2 | - | - | 1 | - | 3 | - | - | 8 |
| Illinois | - | 1 | 1 | 2 | 2 | - | - | - | - | - | - | - | 6 |
| Indiana | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Iowa | - | 1 | 1 | 5 | 1 | 1 | - | - | - | - | 1 | - | 10 |
| Kansas | - | - | - | 1 | - | - | - | 1 | - | - | - | - | 2 |
| Kentucky | - | - | 1 | 2 | - | - | - | - | - | - | - | - | 3 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | 1 | - | - | - | 1 | - | - | 2 |
| Massachusetts | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 |
| Missouri | - | 3 | 4 | 9 | - | 1 | - | 4 | - | 2 | - | - | 23 |
| Montana | - | - | 1 | - | - | - | - | 3 | - | - | - | - | 4 |
| Nevada | - | - | - | - | - | 1 | - | 2 | - | 2 | - | - | 5 |
| New Hampshire | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| New Jersey | - | - | 1 | 1 | 1 | 1 | - | 1 | - | 3 | - | - | 8 |
| New Mexico | - | - | - | 1 | - | - | - | 1 | - | - | - | - | 2 |
| New York | - | 2 | 1 | 2 | - | 1 | - | - | - | 1 | - | - | 7 |
| North Carolina | - | - | 2 | 4 | - | - | - | 3 | - | 1 | 1 | - | 11 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ohio | - | 1 | - | 5 | 2 | - | - | - | - | - | - | - | 8 |
| Oklahoma | - | - | - | 2 | - | 1 | - | - | - | - | - | - | 3 |
| Oregon | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Pennsylvania | - | - | 4 | 5 | 2 | 1 | - | 2 | - | 2 | 1 | - | 17 |
| South Carolina | - | - | 1 | 2 | - | 1 | - | 2 | - | 1 | - | - | 7 |
| South Dakota | - | - | - | - | 1 | - | - | 1 | - | - | - | - | 2 |
| Tennessee | - | 1 | 1 | 6 | 1 | 2 | - | 5 | - | 6 | - | - | 22 |
| Texas | 1 | 1 | 6 | 10 | - | 1 | - | 2 | 1 | 2 | - | - | 24 |
| Utah | 1 | - | - | 3 | 1 | - | - | 1 | - | - | 1 | - | 7 |
| Vermont | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Virginia | - | 1 | 2 | 3 | 1 | - | - | - | - | - | 1 | - | 8 |
| Washington | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| West Virginia | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Wyoming | - | - | - | 1 | 1 | - | - | 1 | - | - | - | - | 3 |
| Total | 4 | 16 | 58 | 91 | 18 | 15 | 2 | 45 | 3 | 41 | 11 | 1 | 305 |

1/ No nonfatal injuries were reported at nonmetal mines and mills for States not listed.

TABLE B-10. - Nonfatal injuries by general work location and main cause at nonmetal mines and mills in the United States, by State 1/, 1964 - Continued

| State | Other surface mining: Sliding or falling material or objects | Other surface mining: Slips or falls of persons | Other surface mining: Handling material | Other surface mining: Handtools | Other surface mining: Stepping or kneeling on sharp or loose objects | Other surface mining: Haulage | Other surface mining: Machinery | Other surface mining: Mine fires or suffocation from fires | Other surface mining: Miscellaneous causes | Total, other surface mining | Total, mining activities | Mills: Sliding or falling material or objects | Mills: Slips or falls of persons | Mills: Handling material | Mills: Handtools | Mills: Stepping or kneeling on sharp or loose objects | Mills: Striking or bumping against objects | Mills: Haulage | Mills: Explosions of gas or dust | Mills: Electricity | Mills: Machinery | Mills: Suffocation (no flame or smoldering) | Mills: Fires or suffocation from fires | Mills: Miscellaneous causes | Total, mills | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | - | - | - | 10 | 2 | 3 | 11 | 2 | - | - | 1 | - | - | 7 | - | - | - | 26 | 36 |
| Arizona | - | - | - | - | - | - | - | - | - | - | 6 | - | - | - | - | - | - | 2 | - | - | 1 | - | - | 1 | 4 | 10 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | 30 | 1 | 7 | 18 | 1 | 4 | 1 | 7 | - | - | 5 | - | - | 4 | 48 | 78 |
| California | 1 | 2 | 8 | - | - | 6 | 2 | - | 1 | 20 | 62 | 3 | 22 | 38 | 5 | 1 | - | 21 | 1 | - | 10 | - | - | 10 | 111 | 173 |
| Colorado | - | - | - | - | - | - | 1 | - | - | 1 | 12 | - | 2 | - | - | - | - | - | - | - | 1 | - | - | - | 3 | 15 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - | 1 | - | - | - | - | - | - | 3 | 4 |
| Florida | - | - | - | 1 | 1 | 1 | - | - | - | 3 | 34 | 1 | 9 | 5 | 3 | - | - | 8 | - | 1 | 5 | 2 | - | 5 | 39 | 73 |
| Georgia | - | - | - | - | - | - | - | - | - | - | 42 | 7 | 44 | 80 | 5 | 5 | 1 | 17 | - | - | 11 | - | 1 | 8 | 179 | 221 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 1 |
| Idaho | - | 1 | 1 | - | - | - | 1 | - | 1 | 4 | 12 | - | 3 | 3 | - | 1 | - | 3 | - | - | 2 | - | - | 3 | 15 | 27 |
| Illinois | - | - | - | - | - | - | - | - | - | - | 17 | 8 | 13 | 34 | 3 | 2 | - | 9 | - | - | 10 | - | - | 4 | 83 | 100 |
| Indiana | - | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 | 8 | - | 2 | - | 2 | - | - | 1 | - | - | 1 | 19 | 20 |
| Iowa | - | - | - | - | - | - | - | - | - | - | 10 | 2 | 7 | 23 | - | 1 | - | 6 | 2 | - | 4 | - | - | 5 | 50 | 60 |
| Kansas | - | - | - | - | - | - | 1 | - | - | 1 | 9 | 1 | 5 | 18 | - | 1 | - | 5 | - | - | 5 | 1 | - | 3 | 39 | 48 |
| Kentucky | - | - | - | - | - | - | - | - | - | - | 27 | - | 1 | 6 | - | - | - | 2 | - | - | - | - | - | 1 | 10 | 37 |
| Louisiana | 1 | 2 | 1 | 1 | - | 2 | 5 | - | - | 12 | 43 | 1 | 11 | 40 | 2 | 2 | 1 | 7 | - | 1 | 1 | - | - | 12 | 78 | 121 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - | 1 | - | - | - | - | - | - | 5 | 5 |
| Maryland | - | - | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 11 | 1 | - | - | 1 | - | - | 1 | - | - | 2 | 20 | 22 |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Michigan | - | - | 1 | - | - | 1 | - | - | - | 2 | 10 | 2 | 7 | 8 | 1 | - | - | 1 | - | - | 19 | 1 | - | 5 | 44 | 54 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | 3 | 4 | 16 | - | 1 | - | 1 | - | - | 3 | - | - | - | 28 | 28 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | 1 | 2 | 6 | 10 | 2 | - | - | 6 | - | 1 | 4 | - | - | 4 | 35 | 36 |
| Missouri | - | - | - | - | - | - | - | - | - | - | 23 | 1 | 10 | 10 | 4 | - | 1 | - | - | - | 5 | - | - | 1 | 32 | 55 |
| Montana | - | - | - | - | - | - | - | - | - | - | 22 | 1 | 3 | 10 | - | - | - | - | - | - | 3 | - | - | 1 | 18 | 40 |
| Nevada | - | - | - | - | - | - | - | - | - | - | 6 | - | 9 | 13 | 1 | 1 | - | 2 | - | - | 3 | - | - | 5 | 34 | 40 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| New Jersey | - | - | - | - | - | - | - | - | - | - | 8 | - | 4 | 1 | - | - | - | 1 | - | - | 2 | - | - | 3 | 11 | 19 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | 170 | 2 | 10 | 16 | 4 | 3 | - | 5 | - | - | 5 | 2 | - | 6 | 53 | 223 |
| New York | - | - | - | - | - | - | - | - | - | - | 63 | 2 | 9 | 27 | 4 | 3 | 1 | 10 | - | 2 | 12 | - | - | 8 | 78 | 141 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | 14 | 1 | 9 | 33 | 3 | 2 | - | 4 | - | - | 10 | - | - | 4 | 66 | 80 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 1 |
| Ohio | - | - | - | - | - | - | - | - | - | - | 33 | 1 | 14 | 34 | 1 | 1 | - | 12 | 1 | - | 11 | - | - | 5 | 80 | 113 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | 3 | - | 1 | 6 | - | - | - | 4 | - | - | - | - | - | - | 11 | 14 |
| Oregon | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 3 | 1 | - | - | 2 | - | - | - | - | - | - | 6 | 7 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | - | 31 | 1 | 17 | 41 | 8 | 1 | - | 13 | - | - | 7 | 1 | - | 5 | 94 | 125 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | 7 | 1 | 5 | 14 | 1 | 1 | 1 | 7 | - | 1 | 2 | - | - | 1 | 34 | 41 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | 5 | - | 1 | 1 | - | - | - | 1 | - | - | 1 | - | - | - | 4 | 9 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | 22 | 1 | 1 | 3 | - | - | - | 2 | - | - | 1 | - | - | 2 | 10 | 32 |
| Texas | - | 5 | 8 | 6 | - | 2 | 6 | 1 | 7 | 35 | 63 | 2 | 14 | 27 | - | 5 | 1 | 17 | - | 1 | 12 | 1 | - | 10 | 90 | 153 |
| Utah | - | - | - | - | - | 2 | - | - | - | 2 | 73 | - | 2 | 4 | 2 | - | - | 1 | - | - | 1 | - | - | 1 | 11 | 84 |
| Vermont | - | - | - | - | - | - | - | - | - | - | 8 | 1 | 3 | 1 | - | - | - | - | - | - | 2 | - | - | 2 | 9 | 17 |
| Virginia | - | - | - | - | - | - | - | - | - | - | 9 | 1 | 4 | 11 | 3 | - | - | 8 | - | - | 7 | - | - | 2 | 36 | 45 |
| Washington | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| West Virginia | - | - | - | - | - | - | - | - | - | - | 6 | 4 | 4 | 12 | - | - | - | 6 | - | - | - | - | 1 | 3 | 30 | 36 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Wyoming | - | - | 1 | - | - | - | - | - | - | 1 | 7 | 1 | 5 | 8 | 4 | 1 | - | 6 | - | - | 4 | - | - | 1 | 30 | 37 |
| Total | 2 | 10 | 20 | 8 | 1 | 14 | 16 | 1 | 9 | 81 | 906 | 57 | 278 | 608 | 61 | 38 | 7 | 203 | 5 | 7 | 178 | 8 | 2 | 128 | 1,580 | 2,486 |

1/ No nonfatal injuries were reported at nonmetal mines and mills for States not listed.

TABLE B-11.- Injuries by general work location and main cause at nonmetal mines and mills in the United States, by degree of injury and mineral industry, 1964

| Degree of injury and mineral industry | Underground | | | | | | | | | | | | | | | Shaft and slope | | Total, underground plus total, shaft and slope |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Falls of roof or back | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosives | Electricity | Machinery | Suffocation (no flame or smoldering) | Miscellaneous causes | Total, underground | Slips or falls of persons | Total, shaft and slope | |
| Fatal and nonfatal: | | | | | | | | | | | | | | | | | | |
| Clay | 7 | 2 | 3 | 10 | 15 | 3 | 2 | - | 16 | - | - | 3 | - | 1 | 62 | - | - | 62 |
| Gypsum | 1 | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 3 | - | - | 3 |
| Phosphate rock | 4 | 11 | 5 | 7 | 10 | 4 | - | - | 6 | 2 | - | 4 | - | - | 53 | - | - | 53 |
| Potash | 3 | 2 | 4 | 8 | 40 | 11 | 3 | 2 | 37 | 2 | 12 | 25 | - | 5 | 154 | - | - | 154 |
| Salt | 4 | 1 | 4 | 5 | 15 | 7 | 2 | 1 | 9 | - | 1 | 8 | 2 | 3 | 62 | - | - | 62 |
| Sulfur | 1 | - | 1 | - | 2 | 1 | - | - | 2 | - | - | - | - | 1 | 8 | - | - | 8 |
| Miscellaneous nonmetals 1/ | 16 | 12 | 8 | 9 | 20 | 6 | 5 | - | 13 | 2 | - | 15 | 3 | 5 | 114 | 1 | 1 | 115 |
| Total | 36 | 28 | 25 | 39 | 102 | 32 | 12 | 3 | 84 | 6 | 13 | 56 | 5 | 15 | 456 | 1 | 1 | 457 |
| Fatal: | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | 1 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | 1 |
| Potash | 1 | - | 1 | - | - | - | - | - | - | - | 2 | - | - | - | 4 | - | - | 4 |
| Salt | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| Total | 1 | - | 1 | - | - | - | - | - | 2 | - | 2 | - | - | - | 6 | 1 | 1 | 7 |
| Permanent total: | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Permanent partial: | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | 2 | - | - | 2 |
| Gypsum | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | 1 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | 1 | - | - | - | 2 | - | - | 1 | - | - | 4 | - | - | 4 |
| Salt | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 1 |
| Sulfur | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Miscellaneous nonmetals 1/ | - | 1 | 1 | - | - | - | - | - | - | - | - | 1 | - | - | 3 | - | - | 3 |
| Total | - | 1 | 1 | - | 3 | - | - | - | 4 | - | - | 3 | - | - | 12 | - | - | 12 |
| Temporary total: | | | | | | | | | | | | | | | | | | |
| Clay | 7 | 2 | 3 | 10 | 14 | 3 | 2 | - | 14 | - | - | 3 | - | 1 | 59 | - | - | 59 |
| Gypsum | 1 | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 2 | - | - | 2 |
| Phosphate rock | 4 | 11 | 5 | 7 | 10 | 4 | - | - | 5 | 2 | - | 4 | - | - | 52 | - | - | 52 |
| Potash | 2 | 2 | 3 | 8 | 39 | 11 | 3 | 2 | 35 | 2 | 10 | 24 | - | 5 | 146 | - | - | 146 |
| Salt | 4 | 1 | 4 | 5 | 15 | 7 | 2 | 1 | 9 | - | 1 | 7 | 2 | 3 | 61 | - | - | 61 |
| Sulfur | 1 | - | 1 | - | 1 | 1 | - | - | 2 | - | - | - | - | 1 | 7 | - | - | 7 |
| Miscellaneous nonmetals 1/ | 16 | 11 | 7 | 9 | 20 | 6 | 5 | - | 13 | 2 | - | 14 | 3 | 5 | 111 | - | - | 111 |
| Total | 35 | 27 | 23 | 39 | 99 | 32 | 12 | 3 | 78 | 6 | 11 | 53 | 5 | 15 | 438 | - | - | 438 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE B-11. - Injuries by general work location and main cause at nonmetal mines and mills in the United States, by degree of injury and mineral industry, 1964 - Continued

| Degree of injury and mineral industry | Surface | | | | | | | | | | Open pit | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Haulage | Machinery | Miscellaneous causes | Total, surface | Total, underground mines | Falls of face or side | Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Electricity | Machinery | Miscellaneous causes | Pneumoconiosis | Total, open pit |
| **Fatal and nonfatal:** | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | 2 | - | - | 1 | 1 | 1 | 5 | 67 | 1 | 10 | 37 | 71 | 13 | 11 | 1 | 23 | 1 | 16 | 9 | 1 | 194 |
| Gypsum | - | - | - | - | - | - | - | - | - | 3 | - | - | 1 | 6 | - | 2 | - | 2 | - | 1 | - | - | 12 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | 53 | - | - | 7 | 5 | 3 | - | 1 | 7 | - | 13 | 2 | - | 38 |
| Potash | 1 | 4 | 4 | 2 | 1 | 2 | 4 | 1 | 19 | 173 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | 7 | 13 | 3 | 1 | 10 | 4 | 1 | 39 | 101 | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | 8 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | 1 | 2 | 1 | - | - | 3 | 1 | 8 | 123 | 5 | 6 | 12 | 10 | 2 | 2 | - | 18 | 2 | 13 | - | - | 70 |
| Total | 1 | 12 | 21 | 6 | - | 13 | 12 | 4 | 71 | 528 | 6 | 16 | 58 | 92 | 18 | 15 | 2 | 50 | 3 | 43 | 11 | 1 | 315 |
| **Fatal:** | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | 3 | - | 2 | - | - | 6 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Potash | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | 1 | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | 1 | 2 | - | - | - | - | - | - | 1 | - | - | - | - | 3 |
| Total | - | - | - | - | - | 1 | - | - | 1 | 8 | 2 | - | - | 1 | - | - | - | 5 | - | 2 | - | - | 10 |
| **Permanent total:** | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| **Permanent partial:** | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Gypsum | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | 2 |
| Potash | - | - | - | - | - | - | 2 | - | 2 | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | 1 | - | - | - | 1 | - | 2 | 5 | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Total | - | - | - | - | - | - | 3 | - | 4 | 16 | - | - | - | 1 | - | - | - | - | 1 | 2 | - | - | 4 |
| **Temporary total:** | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | 2 | - | - | 1 | 1 | 1 | 5 | 64 | 1 | 10 | 37 | 69 | 13 | 11 | 1 | 19 | 1 | 14 | 9 | 1 | 186 |
| Gypsum | - | - | - | - | - | - | - | - | - | 2 | - | - | 1 | 6 | - | 2 | - | 2 | - | 1 | - | - | 12 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | 52 | - | - | 7 | 5 | 3 | - | 1 | 6 | - | 11 | 2 | - | 35 |
| Potash | 1 | 4 | 4 | 2 | 1 | 2 | 2 | 1 | 17 | 163 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | 7 | 13 | 3 | 1 | 9 | 4 | 1 | 38 | 99 | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | 7 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | 1 | 1 | 1 | - | - | 2 | 1 | 6 | 117 | 3 | 6 | 12 | 10 | 2 | 2 | - | 17 | 1 | 13 | - | - | 66 |
| Total | 1 | 12 | 20 | [illegible] | 2 | 12 | 9 | 4 | 66 | 504 | 4 | 16 | 58 | 90 | 18 | 15 | 2 | 44 | 2 | 39 | 11 | 1 | 300 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE B-11. - Injuries by general work location and main cause at nonmetal mines and mills in the United States, by degree of injury and mineral industry, 1964 - Continued

| Degree of injury and mineral industry | Other surface mining: Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Haulage | Machinery | Mine fires or suffocation from fires | Miscellaneous causes | Total, other surface mining | Total, mining activities | Mills: Sliding or falling material or objects | Slips or falls of persons | Handling material | Handtools | Stepping or kneeling on sharp or loose objects | Striking or bumping against objects | Haulage | Explosions of gas or dust | Electricity | Machinery | Suffocation (no flame or smoldering) | Fires or suffocation from fires | Miscellaneous causes | Total, mills | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fatal and nonfatal:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 261 | 39 | 168 | 417 | 40 | 27 | 6 | 140 | 4 | 1 | 101 | 3 | 1 | 68 | 1,015 | 1,276 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 15 | - | 4 | 6 | - | 1 | - | 7 | - | - | 1 | - | - | 1 | 20 | 35 |
| Phosphate rock | - | - | - | 1 | 1 | 1 | - | - | - | 3 | 94 | - | 9 | 6 | - | 1 | - | 11 | - | 1 | 5 | 2 | - | 3 | 38 | 132 |
| Potash | - | - | - | - | - | 2 | - | - | - | 2 | 175 | 2 | 8 | 13 | 5 | 3 | - | 6 | - | 1 | 3 | 1 | - | 4 | 46 | 221 |
| Salt | 1 | 2 | 8 | - | - | 5 | 2 | - | 3 | 21 | 123 | 3 | 28 | 74 | 3 | 4 | - | 22 | 2 | 3 | 21 | 2 | 1 | 20 | 183 | 306 |
| Sulfur | 1 | 7 | 9 | 7 | - | 4 | 11 | 1 | 5 | 45 | 53 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 53 |
| Miscellaneous nonmetals 1/ | - | 1 | 3 | - | - | 2 | 3 | - | 1 | 10 | 203 | 13 | 62 | 92 | 13 | 2 | 1 | 17 | - | 3 | 48 | 1 | - | 32 | 284 | 487 |
| Total | 2 | 10 | 20 | 8 | 1 | 14 | 16 | 1 | 9 | 81 | 924 | 57 | 279 | 608 | 61 | 38 | 7 | 203 | 6 | 9 | 179 | 9 | 2 | 128 | 1,586 | 2,510 |
| **Fatal:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 7 | - | 1 | - | - | - | - | - | 1 | - | 1 | 1 | - | - | 4 | 11 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Potash | - | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 5 |
| Salt | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 5 |
| Total | - | - | - | - | - | - | - | - | - | - | 18 | - | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 | - | - | 6 | 24 |
| **Permanent total:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 2 | 3 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 1 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Potash | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Salt | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sulfur | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | 3 | 4 |
| **Permanent partial:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 3 | - | - | 8 | 1 | - | - | 1 | - | - | 15 | - | - | - | 25 | 28 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 3 |
| Potash | - | - | - | - | - | - | - | - | - | - | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 |
| Salt | - | - | - | - | - | - | 2 | - | - | 2 | 3 | - | - | 1 | 1 | - | - | - | - | - | 2 | - | - | - | 4 | 7 |
| Sulfur | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Miscellaneous nonmetals 1/ | - | - | - | - | - | - | - | - | - | - | 6 | - | - | 4 | 1 | - | - | - | - | - | 3 | - | - | - | 8 | 14 |
| Total | - | - | - | - | - | - | 2 | - | - | 2 | 22 | - | - | 13 | 3 | - | - | 1 | - | - | 21 | - | - | - | 38 | 60 |
| **Temporary total:** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clay | - | - | - | - | - | - | - | - | - | - | 250 | 39 | 167 | 409 | 39 | 27 | 6 | 139 | 2 | 1 | 85 | 1 | 1 | 68 | 984 | 1,234 |
| Gypsum | - | - | - | - | - | - | - | - | - | - | 14 | - | 4 | 6 | - | 1 | - | 7 | - | - | - | - | - | 1 | 19 | 33 |
| Phosphate rock | - | - | - | 1 | 1 | 1 | - | - | - | 3 | 90 | - | 9 | 6 | - | 1 | - | 11 | - | 1 | 4 | 2 | - | 3 | 37 | 127 |
| Potash | - | - | - | - | - | 2 | - | - | - | 2 | 165 | 2 | 8 | 13 | 5 | 3 | - | 6 | - | - | 3 | 1 | - | 4 | 45 | 210 |
| Salt | 1 | 2 | 8 | - | - | 5 | - | - | 3 | 19 | 119 | 3 | 28 | 73 | 2 | 4 | - | 22 | 2 | 3 | 19 | 2 | 1 | 20 | 179 | 298 |
| Sulfur | 1 | 7 | 9 | 7 | - | 4 | 11 | 1 | 5 | 45 | 52 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 52 |
| Miscellaneous nonmetals 1/ | - | 1 | 3 | - | - | 2 | 3 | - | 1 | 10 | 193 | 13 | 62 | 88 | 12 | 2 | 1 | 17 | - | 2 | 45 | 1 | - | 32 | 275 | 468 |
| Total | 2 | 10 | 20 | 8 | 1 | 14 | 14 | 1 | 9 | 79 | 883 | 57 | 278 | 595 | 58 | 38 | 7 | 202 | 4 | 7 | 156 | 7 | 2 | 128 | 1,539 | 2,422 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE B-12. - Injury experience and employment data by general work locstion at nonmetal mines and mills in the United States, by mineral industry, 1964

| Mineral industry | Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grsnd total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Injuries** | | | | | | | | | | | | | | | | |
| Clay | 1 | - | 1 | 6 | - | 7 | 4 | 11 | 61 | 5 | 66 | 188 | - | 254 | 1,011 | 1,265 |
| Gypsum | - | - | - | - | - | - | - | - | 3 | - | 3 | 12 | - | 15 | 20 | 35 |
| Phosphate rock | 1 | - | 1 | 1 | - | 2 | - | 2 | 52 | - | 52 | 37 | 3 | 92 | 38 | 130 |
| Potssh | 4 | - | 4 | - | - | 4 | 1 | 5 | 150 | 19 | 169 | - | 2 | 171 | 45 | 216 |
| Salt | - | 1 | 1 | - | - | 1 | - | 1 | 62 | 38 | 100 | 1 | 21 | 122 | 183 | 305 |
| Sulfur | - | - | - | - | - | - | - | - | 8 | - | 8 | - | 45 | 53 | - | 53 |
| Miscellaneous nonmetals 1/ | 1 | - | 1 | 3 | - | 4 | 1 | 5 | 114 | 8 | 122 | 67 | 10 | 199 | 283 | 482 |
| Total | 7 | 1 | 8 | 10 | - | 18 | 6 | 24 | 450 | 70 | 520 | 305 | 81 | 906 | 1,580 | 2,486 |
| **Frequency rates per million man-hours** | | | | | | | | | | | | | | | | |
| Clay | 0.98 | - | 0.82 | 0.74 | - | 0.75 | 0.12 | 0.27 | 59.81 | 25.67 | 54.33 | 23.14 | - | 27.12 | 31.54 | 30.54 |
| Gypsum | - | - | - | - | - | - | - | - | 3.90 | - | 3.26 | 10.24 | - | 7.17 | 5.77 | 6.30 |
| Phosphate rock | .96 | - | .81 | .26 | - | .40 | - | .19 | 50.02 | - | 42.29 | 9.80 | 54.00 | 18.17 | 6.89 | 12.29 |
| Potash | 1.19 | - | .75 | - | - | .74 | .38 | .62 | 44.76 | 9.49 | 31.57 | - | 66.14 | 31.76 | 16.88 | 26.83 |
| Salt | - | 1.09 | .37 | - | - | .29 | - | .07 | 34.56 | 41.32 | 36.85 | 19.74 | 29.04 | 34.98 | 16.30 | 20.72 |
| Sulfur | - | - | - | - | - | - | - | - | 133.12 | - | 109.02 | - | 11.16 | 12.91 | - | 12.84 |
| Miscellaneous nonmetals 1/ | .54 | - | .46 | .88 | - | .62 | .06 | .22 | 61.36 | 23.77 | 55.60 | 19.58 | 11.59 | 30.72 | 17.14 | 20.97 |
| Total or average | .71 | .26 | .58 | .60 | - | .50 | .08 | .22 | 45.49 | 18.39 | 37.96 | 18.43 | 14.13 | 25.18 | 22.11 | 23.14 |
| **Severity rates per million man-hours** | | | | | | | | | | | | | | | | |
| Clay | 5,883 | - | 4,940 | 4,431 | - | 4,484 | 749 | 1,593 | 4,479 | 652 | 3,865 | 1,364 | - | 1,685 | 1,276 | 1,368 |
| Gypsum | - | - | - | - | - | - | - | - | 582 | - | 487 | 157 | - | 302 | 1,804 | 1,239 |
| Phosphate rock | 5,771 | - | 4,880 | 1,588 | - | 2,370 | - | 1,135 | 1,271 | - | 1,074 | 1,026 | 1,260 | 1,040 | 1,017 | 1,028 |
| Potash | 7,161 | - | 4,483 | - | - | 4,458 | 2,251 | 3,727 | 1,708 | 1,587 | 1,663 | - | 4,729 | 1,680 | 394 | 1,254 |
| Salt | - | 6,523 | 2,211 | - | - | 1,720 | - | 408 | 2,122 | 1,891 | 2,043 | 39 | 4,935 | 2,614 | 657 | 1,121 |
| Sulfur | - | - | - | - | - | - | - | - | 5,841 | - | 4,783 | - | 338 | 418 | - | 416 |
| Miscellaneous nonmetals 1/ | 3,230 | - | 2,734 | 5,261 | - | 3,705 | 363 | 1,305 | 1,921 | 1,287 | 1,823 | 1,112 | 627 | 1,289 | 822 | 953 |
| Total or average | 4,245 | 1,576 | 3,504 | 3,626 | - | 3,002 | 504 | 1,340 | 2,000 | 1,439 | 1,844 | 1,145 | 992 | 1,387 | 1,046 | 1,160 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromide, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, mica, mineral pigments, perlite, pumice, sodium, talc, aoapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE B-12. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by mineral industry, 1964 - Continued

| Mineral industry | Active operations | | | | | Men employed | | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Under-ground mines | Open pit mines | Other surface mining | Total mining activities | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | | | | Underground | Surface | Total | | | | | | | | | | | |
| Clay | 63 | 1,236 | 4 | 1,303 | 522 | 554 | 114 | 668 | 4,767 | 15 | 5,450 | 15,250 | 20,700 | | 229 | 210 | 223 | 212 | 261 |
| Gypsum | 19 | 62 | - | 81 | 47 | 380 | 72 | 452 | 567 | - | 1,019 | 1,589 | 2,608 | | 254 | 255 | - | 255 | 278 |
| Phosphate rock | 12 | 63 | 10 | 85 | 39 | 473 | 87 | 560 | 1,536 | 28 | 2,124 | 2,163 | 4,287 | | 277 | 304 | 248 | 296 | 319 |
| Potash | 12 | - | 1 | 13 | 9 | 1,277 | 733 | 2,010 | - | 12 | 2,022 | 1,003 | 3,025 | | 333 | - | 315 | 333 | 332 |
| Salt | 18 | 8 | 91 | 117 | 64 | 770 | 414 | 1,184 | 31 | 336 | 1,551 | 4,870 | 6,421 | | 275 | 207 | 269 | 273 | 288 |
| Sulfur | 1 | 1 | 11 | 13 | 2 | 24 | 5 | 29 | 5 | 1,279 | 1,313 | 11 | 1,324 | | 316 | 2 | 365 | 363 | 237 |
| Miscellaneous nonmetals 1/ | 88 | 445 | 45 | 578 | 228 | 955 | 178 | 1,133 | 2,033 | 442 | 3,608 | 7,081 | 10,689 | | 241 | 208 | 242 | 223 | 291 |
| Total or average | 213 | 1,815 | 162 | 2,190 | 911 | 4,433 | 1,603 | 6,036 | 8,939 | 2,112 | 17,087 | 31,967 | 49,054 | | 282 | 228 | 321 | 259 | 279 |

| Mineral industry | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Clay | 127,852 | 25,032 | 152,884 | 999,929 | 3,350 | 1,156,163 | 3,981,978 | 5,138,141 | 1,019,927 | 194,761 | 1,214,688 | 8,125,007 | 26,796 | 9,366,491 | 32,058,143 | 41,424,634 |
| Gypsum | 95,958 | 18,747 | 114,705 | 144,810 | - | 259,515 | 441,995 | 701,510 | 770,132 | 149,978 | 920,110 | 1,171,319 | - | 2,091,429 | 3,466,558 | 5,557,987 |
| Phosphate rock | 131,303 | 23,660 | 154,963 | 467,379 | 6,930 | 629,272 | 689,683 | 1,318,955 | 1,039,628 | 189,982 | 1,229,610 | 3,777,418 | 55,560 | 5,062,588 | 5,514,180 | 10,576,768 |
| Potash | 418,929 | 250,275 | 669,204 | - | 3,780 | 672,984 | 333,222 | 1,006,206 | 3,351,440 | 2,002,302 | 5,353,742 | - | 30,240 | 5,383,982 | 2,665,773 | 8,049,755 |
| Salt | 213,586 | 112,363 | 325,949 | 6,407 | 90,424 | 422,780 | 1,404,617 | 1,827,397 | 1,793,798 | 919,759 | 2,713,557 | 50,652 | 723,204 | 3,487,413 | 11,229,316 | 14,716,729 |
| Sulfur | 7,512 | 1,661 | 9,173 | 10 | 466,840 | 476,023 | 2,606 | 478,629 | 60,096 | 13,285 | 73,381 | 80 | 4,032,808 | 4,106,269 | 20,846 | 4,127,115 |
| Miscellaneous nonmetals 1/ | 231,140 | 41,603 | 272,743 | 423,457 | 107,046 | 803,246 | 2,059,673 | 2,862,919 | 1,857,811 | 336,566 | 2,194,377 | 3,421,720 | 862,476 | 6,478,573 | 16,506,308 | 22,984,881 |
| Total | 1,226,280 | 473,341 | 1,699,621 | 2,041,992 | 678,370 | 4,419,983 | 8,913,774 | 13,333,757 | 9,892,832 | 3,806,633 | 13,699,465 | 16,546,196 | 5,731,084 | 35,976,745 | 71,461,124 | 107,437,869 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromide, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.

TABLE B-13. - Injury experience and employment data by general work location at miscellaneous nonmetal mines and mills in the United States, by mineral industry, 1964

| Mineral industry | Injuries | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Asbestos | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 3 | - | 6 | 6 | 12 |
| Barite | - | - | - | - | - | - | - | - | 30 | - | 30 | 19 | - | 49 | 74 | 123 |
| Boron minerals | 1 | - | 1 | - | - | 1 | - | 1 | 1 | - | 1 | - | - | 1 | 13 | 14 |
| Feldspar | - | - | - | - | - | - | - | - | 1 | - | 1 | 5 | - | 6 | 11 | 17 |
| Fluorspar | - | - | - | - | - | - | 1 | 1 | 31 | - | 31 | - | - | 31 | 12 | 43 |
| Magnesite | - | - | - | - | - | - | - | - | - | - | - | 9 | 2 | 11 | 49 | 60 |
| Mica | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 4 | - | 7 | 3 | 10 |
| Pumice | - | - | - | - | - | - | - | - | - | - | - | 4 | 4 | 8 | 4 | 12 |
| Sodium compounds | - | - | - | - | - | - | - | - | 2 | 1 | 3 | - | 1 | 4 | 9 | 13 |
| Talc, soapstone, and pyrophyllite | - | - | - | 2 | - | 2 | - | 2 | 43 | 5 | 48 | 9 | - | 57 | 18 | 75 |
| Other nonmetals 1/ | - | - | - | 1 | - | 1 | - | 1 | 2 | - | 2 | 14 | 3 | 19 | 84 | 103 |
| Total | 1 | - | 1 | 3 | - | 4 | 1 | 5 | 114 | 8 | 122 | 67 | 10 | 199 | 283 | 482 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Asbestos | - | - | - | - | - | - | - | - | 17.07 | 37.55 | 20.86 | 15.41 | - | 17.73 | 10.03 | 12.81 |
| Barite | - | - | - | - | - | - | - | - | 255.24 | - | 206.93 | 27.14 | - | 57.99 | 46.70 | 50.62 |
| Boron minerals | 105.51 | - | 65.53 | - | - | 2.60 | - | 0.28 | 105.51 | - | 65.53 | - | - | 2.60 | 4.06 | 3.90 |
| Feldspar | - | - | - | - | - | - | - | - | 36.42 | - | 30.82 | 16.36 | - | 17.75 | 18.38 | 18.15 |
| Fluorspar | - | - | - | - | - | - | 1.94 | .78 | 48.61 | - | 41.97 | - | - | 40.69 | 23.27 | 33.66 |
| Magnesite | - | - | - | - | - | - | - | - | - | - | - | 29.15 | 5.21 | 15.87 | 20.40 | 19.39 |
| Mica | - | - | - | - | - | - | - | - | 103.55 | 200.32 | 123.43 | 19.34 | - | 29.45 | 6.95 | 14.94 |
| Pumice | - | - | - | - | - | - | - | - | - | - | - | 10.71 | 391.24 | 20.85 | 30.69 | 23.34 |
| Sodium compounds | - | - | - | - | - | - | - | - | 5.05 | 11.41 | 6.20 | - | 5.85 | 6.10 | 5.87 | 5.94 |
| Talc, soapstone, and pyrophyllite | - | - | - | 13.26 | - | 2.77 | - | 1.19 | 87.29 | 71.18 | 85.28 | 59.67 | - | 78.96 | 18.70 | 44.53 |
| Other nonmetals 1/ | - | - | - | 1.25 | - | .89 | - | .18 | 49.24 | - | 41.20 | 17.50 | 11.11 | 16.99 | 18.48 | 18.18 |
| Total or average | .54 | - | .46 | .88 | - | .62 | .06 | .22 | 61.36 | 23.77 | 55.60 | 19.58 | 11.59 | 30.72 | 17.14 | 20.97 |

1/ Abrasives, bromine, calcium chloride, diatomite, epsomite, graphite, greensand, iodine, kyanite, lithium, mineral pigments, perlite, vermiculite, and wollastonite.

TABLE B-13. - Injury experience and employment data by general work location at miscellaneous nonmetal mines and mills in the United States, by mineral industry, 1964 - Continued

| Mineral industry | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Asbestos | - | - | - | - | - | - | - | - | 1,204 | 751 | 1,120 | 164 | - | 570 | 191 | 328 |
| Barite | - | - | - | - | - | - | - | - | 2,850 | - | 2,311 | 804 | - | 1,063 | 1,235 | 1,175 |
| Boron minerals | 633,045 | - | 393,185 | - | - | 15,606 | - | 1,672 | 950 | - | 590 | - | - | 23 | 226 | 204 |
| Feldspar | - | - | - | - | - | - | - | - | 728 | - | 616 | 514 | - | 524 | 7,900 | 5,237 |
| Fluorspar | - | - | - | - | - | - | 11,636 | 4,697 | 999 | - | 862 | - | - | 836 | 266 | 606 |
| Magnesite | - | - | - | - | - | - | - | - | - | - | - | 2,070 | 906 | 1,424 | 1,089 | 1,164 |
| Mica | - | - | - | - | - | - | - | - | 14,342 | 1,002 | 11,602 | 1,470 | - | 2,465 | 86 | 930 |
| Pumice | - | - | - | - | - | - | - | - | - | - | - | 562 | 10,955 | 839 | 169 | 669 |
| Sodium compounds | - | - | - | - | - | - | - | - | 649 | 856 | 687 | - | 6 | 508 | 374 | 414 |
| Talc, soapstone, and pyrophyllite | - | - | - | 79,566 | - | 16,623 | - | 7,125 | 3,816 | 4,741 | 3,932 | 1,253 | - | 3,327 | 303 | 1,600 |
| Other nonmetals 1/ | - | - | - | 7,501 | - | 5,365 | - | 1,059 | 295 | - | 247 | 2,140 | 296 | 1,613 | 520 | 736 |
| Total or average | 3,230 | - | 2,734 | 5,261 | - | 3,705 | 363 | 1,305 | 1,921 | 1,287 | 1,823 | 1,112 | 627 | 1,289 | 822 | 953 |

| Mineral industry | Active operations | | | | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | | | | Underground | Surface | Total | | | | | | | | | | |
| Asbestos | 3 | 7 | - | 10 | 7 | 75 | 17 | 92 | 107 | - | 199 | 279 | 478 | 195 | 227 | - | 213 | 268 |
| Barite | 6 | 50 | - | 56 | 40 | 73 | 19 | 92 | 394 | - | 486 | 737 | 1,223 | 197 | 221 | - | 216 | 268 |
| Boron minerals | 3 | 3 | 2 | 8 | 4 | 6 | 4 | 10 | 147 | 6 | 163 | 1,326 | 1,489 | 195 | 303 | 260 | 295 | 302 |
| Feldspar | 8 | 79 | - | 87 | 10 | 17 | 2 | 19 | 227 | - | 246 | 254 | 500 | 214 | 167 | - | 171 | 292 |
| Fluorspar | 22 | 10 | - | 32 | 10 | 325 | 52 | 377 | 23 | - | 400 | 264 | 664 | 245 | 126 | - | 238 | 244 |
| Magnesite | - | 14 | 21 | 35 | 16 | - | - | - | 164 | 139 | 303 | 1,080 | 1,383 | - | 228 | 345 | 282 | 279 |
| Mica | 2 | 33 | 2 | 37 | 13 | 8 | 2 | 10 | 133 | 4 | 147 | 205 | 352 | 304 | 193 | 199 | 201 | 263 |
| Pumice | - | 119 | 3 | 122 | 24 | - | - | - | 303 | 10 | 313 | 87 | 400 | - | 153 | 128 | 152 | 185 |
| Sodium compounds | 3 | 1 | 1 | 5 | 5 | 199 | 44 | 243 | 1 | 152 | 396 | 617 | 1,013 | 248 | 209 | 141 | 207 | 310 |
| Talc, soapstone, and pyrophyllite | 33 | 51 | 2 | 86 | 33 | 230 | 32 | 262 | 117 | 5 | 384 | 429 | 813 | 263 | 160 | 205 | 230 | 270 |
| Other nonmetals 1/ | 8 | 78 | 14 | 100 | 66 | 22 | 6 | 28 | 417 | 126 | 571 | 1,803 | 2,374 | 219 | 235 | 263 | 241 | 316 |
| Total or average | 88 | 445 | 45 | 578 | 228 | 955 | 178 | 1,133 | 2,033 | 442 | 3,608 | 7,081 | 10,689 | 241 | 208 | 242 | 223 | 291 |

1/ Abrasives, bromine, calcium chloride, diatomite, epsomite, graphite, greensand, iodine, kyanite, lithium, mineral pigments, perlite, vermiculite, and wollastonite.

TABLE B-13. - Injury experience and employment data by general work location at miscellaneous nonmetal mines and mills in the United States, by mineral industry, 1964 - Continued

| Mineral industry | Man-days worked | | | | | | | | | Man-hours worked | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Asbestos | 14,645 | 3,329 | 17,974 | 24,338 | - | 42,312 | 74,799 | 117,111 | 117,158 | 26,632 | 143,790 | 194,700 | - | 338,490 | 598,383 | 936,873 |
| Barite | 14,692 | 3,430 | 18,122 | 87,031 | - | 105,153 | 197,563 | 302,716 | 117,536 | 27,439 | 144,975 | 700,044 | - | 845,019 | 1,584,691 | 2,429,710 |
| Boron minerals | 1,219 | 732 | 1,951 | 44,590 | 1,560 | 48,101 | 400,620 | 448,721 | 9,478 | 5,782 | 15,260 | 356,720 | 12,480 | 384,460 | 3,204,964 | 3,589,424 |
| Feldspar | 3,433 | 624 | 4,057 | 37,990 | - | 42,047 | 74,076 | 116,123 | 27,457 | 4,992 | 32,449 | 305,615 | - | 338,064 | 598,387 | 936,451 |
| Fluorspar | 79,716 | 12,618 | 92,334 | 2,899 | - | 95,233 | 64,454 | 159,687 | 637,729 | 100,945 | 738,674 | 23,214 | - | 761,888 | 515,640 | 1,277,528 |
| Magnesite | - | - | - | 37,427 | 47,926 | 85,353 | 301,470 | 386,823 | - | - | - | 308,759 | 384,170 | 692,929 | 2,401,780 | 3,094,709 |
| Mica | 2,414 | 624 | 3,038 | 25,710 | 796 | 29,544 | 53,957 | 83,501 | 19,314 | 4,992 | 24,306 | 206,826 | 6,568 | 237,700 | 431,865 | 669,565 |
| Pumice | - | - | - | 46,422 | 1,281 | 47,703 | 16,056 | 63,759 | - | - | - | 373,486 | 10,224 | 383,710 | 130,326 | 514,036 |
| Sodium compounds | 49,388 | 10,953 | 60,341 | 209 | 21,364 | 81,914 | 191,500 | 273,414 | 395,897 | 87,624 | 483,521 | 1,672 | 170,914 | 656,107 | 1,532,009 | 2,188,116 |
| Talc, soapstone, and pyrophyllite | 60,483 | 8,303 | 68,786 | 18,682 | 1,024 | 88,492 | 115,951 | 204,443 | 492,622 | 70,242 | 562,864 | 150,819 | 8,194 | 721,877 | 962,325 | 1,684,202 |
| Other nonmetals 1/ | 5,150 | 990 | 6,140 | 98,159 | 33,095 | 137,394 | 569,227 | 706,621 | 40,620 | 7,918 | 48,538 | 799,865 | 269,926 | 1,118,329 | 4,545,938 | 5,664,267 |
| Total | 231,140 | 41,603 | 272,743 | 423,457 | 107,046 | 803,246 | 2,059,673 | 2,862,919 | 1,857,811 | 336,566 | 2,194,377 | 3,421,720 | 862,476 | 6,478,573 | 16,506,308 | 22,984,881 |

1/ Abrasives, bromine, calcium chloride, diatomite, epsomite, graphite, greensand, iodine, kyanite, lithium, mineral pigments, perlite, vermiculite, and wollastonite.

TABLE B-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1964

| State | Injuries: Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities | Nonfatal: Mills | Nonfatal: Grand total 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | - | 1 | - | 1 | 7 | - | 8 | 25 | 33 |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 34 | 34 |
| California | 1 | - | 1 | - | - | 1 | 1 | 2 | 1 | - | 1 | 2 | - | 3 | 45 | 48 |
| Colorado | - | - | - | - | - | - | - | - | 2 | - | 2 | - | - | 2 | 3 | 5 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | 5 | - | 5 | 12 | 17 |
| Georgia | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 34 | - | 34 | 171 | 205 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 14 | 14 |
| Illinois | - | - | - | - | - | - | - | - | - | - | - | 6 | - | 6 | 72 | 78 |
| Indiana | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - | 1 | 18 | 19 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 10 | - | 10 | 50 | 60 |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 17 | 19 |
| Kentucky | - | - | - | 1 | - | 1 | - | 1 | 4 | - | 4 | 3 | - | 7 | 7 | 14 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 6 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 5 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 20 | 21 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 |
| Minnesota | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | 28 | 28 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 30 | 31 |
| Missouri | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 12 | - | 12 | 8 | 20 |
| Montana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 3 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 8 | - | 8 | 7 | 15 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| New York | - | - | - | - | - | - | - | - | - | - | - | 6 | - | 6 | 35 | 41 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 55 | 59 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| Ohio | - | - | - | - | - | - | - | - | 12 | - | 12 | 8 | - | 20 | 63 | 83 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 11 | 13 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 4 |
| Pennsylvania | - | - | - | - | - | - | 1 | 1 | 12 | 2 | 14 | 17 | - | 31 | 94 | 125 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 30 | 34 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 2 | 3 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 16 | - | 16 | 9 | 25 |
| Texas | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 22 | - | 22 | 56 | 78 |
| Utah | - | - | - | - | - | - | 1 | 1 | 24 | 3 | 27 | 6 | - | 33 | 4 | 37 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 24 | 28 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | 5 | - | 5 | 1 | - | 6 | 22 | 28 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 20 | 23 |
| Other States 3/ and/or combined 2/ | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 2 | 3 |
| Total | 1 | - | 1 | 6 | - | 7 | 4 | 11 | 61 | 5 | 66 | 188 | - | 254 | 1,011 | 1,265 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Delaware with 1 operation, Hawaii with 1, Massachusetts with 4, Nevada with 4, and Vermont with 1.

TABLE B-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1964 - Continued

| State | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | - | - | - | - | - | - | - | - | 27.46 | - | 18.82 | 41.68 | - | 36.19 | 17.17 | 19.67 |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | 22.28 | - | 22.28 | - | 19.59 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 71.46 | 63.28 |
| California | 6.27 | - | 5.04 | - | - | 2.26 | 0.93 | 1.32 | 6.27 | - | 5.04 | 8.18 | - | 6.77 | 41.91 | 31.65 |
| Colorado | - | - | - | - | - | - | - | - | 53.70 | - | 45.10 | - | - | 11.98 | 22.05 | 16.50 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | 29.26 | - | 28.56 | 22.89 | 24.31 |
| Georgia | - | - | - | 0.66 | - | .66 | - | .12 | - | - | - | 22.45 | - | 22.45 | 25.06 | 24.58 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 149.14 | 107.70 |
| Illinois | - | - | - | - | - | - | - | - | - | - | - | 36.98 | - | 33.26 | 49.42 | 47.64 |
| Indiana | - | - | - | - | - | - | 1.34 | 1.20 | - | - | - | 11.36 | - | 11.22 | 24.12 | 22.74 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 71.81 | - | 71.81 | 53.32 | 55.71 |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | 31.40 | - | 31.40 | 58.70 | 53.78 |
| Kentucky | - | - | - | 8.34 | - | 5.68 | - | 2.50 | 120.85 | - | 105.27 | 25.03 | - | 39.76 | 31.16 | 34.94 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 21.40 | 16.76 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 55.91 | 27.41 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 18.08 | - | 15.33 | 47.36 | 43.07 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6.76 | 6.53 |
| Minnesota | - | - | - | 25.78 | - | 25.78 | - | 2.04 | - | - | - | - | - | - | 62.03 | 57.12 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 3.21 | - | 3.21 | 28.48 | 22.70 |
| Missouri | - | - | - | 2.48 | - | 2.45 | - | 1.14 | - | - | - | 29.74 | - | 29.46 | 16.94 | 22.74 |
| Montana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 42.08 | 36.54 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | 4.77 | - | 4.77 | - | 2.12 | - | - | - | 38.15 | - | 38.15 | 26.82 | 31.87 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| New York | - | - | - | - | - | - | - | - | - | - | - | 26.65 | - | 26.65 | 41.34 | 38.25 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | 17.18 | - | 17.18 | 31.86 | 30.11 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| Ohio | - | - | - | - | - | - | - | - | 50.69 | - | 42.07 | 11.82 | - | 20.78 | 21.97 | 21.67 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 10.92 | - | 10.92 | 43.27 | 29.73 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 33.42 | 26.41 |
| Pennsylvania | - | - | - | - | - | - | .44 | .29 | 53.16 | 34.25 | 49.27 | 18.17 | - | 25.41 | 41.61 | 35.93 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 14.93 | - | 14.93 | 21.57 | 20.50 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 19.87 | - | 19.87 | 10.27 | 12.24 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 66.29 | - | 66.29 | 16.54 | 31.82 |
| Texas | - | - | - | 1.80 | - | 1.77 | - | .42 | - | - | - | 39.59 | - | 38.99 | 30.87 | 32.80 |
| Utah | - | - | - | - | - | - | 22.72 | 3.58 | 166.13 | 2,405.77 | 185.30 | 67.16 | - | 140.40 | 90.88 | 132.59 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 35.21 | - | 35.21 | 39.72 | 39.00 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | 46.09 | - | 41.43 | 49.43 | - | 42.58 | 30.26 | 32.26 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 19.22 | 18.70 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | 12.67 | - | 12.67 | 42.24 | 32.39 |
| Other States 3/ and/or combined 2/ | - | - | - | - | - | - | - | - | - | - | - | 35.40 | - | 31.01 | 8.34 | 11.03 |
| Total or average | .98 | - | .82 | .74 | - | .75 | .12 | .27 | 59.81 | 25.67 | 54.33 | 23.14 | - | 27.12 | 31.54 | 30.54 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Delaware with 1 operation, Hawaii with 1, Massachusetts with 4, Nevada with 4, and Vermont with 1.

TABLE B-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1964 - Continued

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | - | - | - | - | - | - | - | - | 55 | - | 38 | 1,804 | - | 1,380 | 267 | 414 |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | 557 | - | 557 | - | 490 |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3,304 | 2,926 |
| California | 37,622 | - | 30,250 | - | - | 13,546 | 5,588 | 7,912 | 401 | - | 323 | 360 | - | 343 | 1,154 | 917 |
| Colorado | - | - | - | - | - | - | - | - | 913 | - | 767 | - | - | 204 | 2,131 | 1,069 |
| Connecticut | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | - | - | - | - | - | - | - | - | 35,670 | - | 34,822 | 361 | 8,988 |
| Georgia | - | - | - | 3,961 | - | 3,961 | - | 720 | - | - | - | 694 | - | 694 | 641 | 651 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3,782 | 2,731 |
| Illinois | - | - | - | - | - | - | - | - | - | - | - | 462 | - | 416 | 2,432 | 2,210 |
| Indiana | - | - | - | - | - | - | 8,040 | 7,182 | - | - | - | 273 | - | 269 | 871 | 807 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 783 | - | 783 | 7,272 | 6,433 |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | 2,260 | - | 2,260 | 843 | 1,098 |
| Kentucky | - | - | - | 50,068 | - | 34,706 | - | 14,973 | 3,082 | - | 2,684 | 58 | - | 619 | 628 | 624 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 788 | 617 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 559 | 274 |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 127 | - | 107 | 886 | 781 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 162 | 157 |
| Minnesota | - | - | - | 154,679 | - | 154,679 | - | 12,240 | - | - | - | - | - | - | 1,012 | 932 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 48 | - | 48 | 2,239 | 1,739 |
| Missouri | - | - | - | 14,868 | - | 14,728 | - | 6,821 | - | - | - | 644 | - | 638 | 201 | 404 |
| Montana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 589 | 512 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | - | - | 28,611 | - | 28,611 | - | 12,747 | - | - | - | 753 | - | 753 | 1,828 | 1,349 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| New York | - | - | - | - | - | - | - | - | - | - | - | 822 | - | 822 | 763 | 775 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | 657 | - | 657 | 945 | 911 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| Ohio | - | - | - | - | - | - | - | - | 1,964 | - | 1,630 | 296 | - | 691 | 885 | 836 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 262 | - | 262 | 378 | 329 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 760 | 601 |
| Pennsylvania | - | - | - | - | - | - | 2,656 | 1,724 | 15,647 | 959 | 12,628 | 282 | - | 3,157 | 879 | 1,678 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 728 | - | 728 | 891 | 864 |
| South Dakota | - | - | - | - | - | - | - | - | - | - | - | 60 | - | 60 | 555 | 453 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 1,347 | - | 1,347 | 691 | 892 |
| Texas | - | - | - | 10,796 | - | 10,632 | - | 2,523 | - | - | - | 900 | - | 886 | 3,700 | 3,032 |
| Utah | - | - | - | - | - | - | 136,326 | 21,501 | 1,959 | 56,937 | 2,429 | 3,940 | - | 3,004 | 727 | 2,645 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 2,104 | - | 2,104 | 1,671 | 1,740 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| West Virginia | - | - | - | - | - | - | - | - | 793 | - | 713 | 692 | - | 710 | 237 | 313 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 106 | 103 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | 933 | - | 933 | 596 | 708 |
| Other States 3/ and/ or combined 2/ | - | - | - | - | - | - | - | - | - | - | - | 850 | - | 744 | 92 | 169 |
| Total or average | 5,883 | - | 4,940 | 4,431 | - | 4,484 | 749 | 1,593 | 4,479 | 652 | 3,865 | 1,364 | - | 1,685 | 1,276 | 1,368 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Delaware with 1 operation, Hawaii with 1, Massachusetts with 4, Nevada with 4, and Vermont with 1.

TABLE B-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1964 - Continued

| State | Active operations: Mines | Active operations: Mills | Men employed: Underground mines: Underground | Men employed: Underground mines: Surface | Men employed: Underground mines: Total | Men employed: Open pit mines | Men employed: Other surface mining | Men employed: Total mining activities | Men employed: Mills | Men employed: Grand total 1/ | Average days active: Underground mines | Average days active: Open pit mines | Average days active: Other surface mining | Average days active: Total mining activities | Average days active: Mills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 36 | 18 | 22 | 12 | 34 | 90 | - | 124 | 678 | 802 | 205 | 233 | - | 225 | 266 |
| Arizona | 9 | 2 | - | - | - | 27 | - | 27 | 3 | 30 | - | 208 | - | 208 | 257 |
| Arkansas | 22 | 7 | - | - | - | 45 | - | 45 | 238 | 283 | - | 171 | - | 171 | 250 |
| California | 98 | 36 | 79 | 20 | 99 | 237 | - | 336 | 604 | 940 | 250 | 128 | - | 164 | 218 |
| Colorado | 65 | 14 | 23 | 5 | 28 | 139 | - | 167 | 114 | 281 | 165 | 113 | - | 127 | 151 |
| Connecticut | 6 | 1 | - | - | - | 18 | - | 18 | 32 | 50 | - | 213 | - | 213 | 254 |
| Florida | 11 | 8 | - | - | - | 72 | 2 | 74 | 226 | 300 | - | 293 | 260 | 293 | 284 |
| Georgia | 41 | 38 | - | - | - | 695 | - | 695 | 2,660 | 3,355 | - | 271 | - | 271 | 321 |
| Idaho | 6 | 3 | - | - | - | 28 | - | 28 | 45 | 73 | - | 161 | - | 161 | 261 |
| Illinois | 38 | 22 | 7 | 2 | 9 | 97 | - | 106 | 780 | 886 | 252 | 204 | - | 208 | 233 |
| Indiana | 35 | 15 | 1 | - | 1 | 71 | - | 72 | 362 | 434 | 160 | 155 | - | 155 | 258 |
| Iowa | 26 | 20 | - | - | - | 68 | - | 68 | 494 | 562 | - | 255 | - | 255 | 234 |
| Kansas | 19 | 8 | - | - | - | 47 | - | 47 | 180 | 227 | - | 167 | - | 167 | 201 |
| Kentucky | 41 | 12 | 14 | 2 | 16 | 110 | 9 | 135 | 132 | 267 | 297 | 135 | 253 | 162 | 212 |
| Louisiana | 14 | 5 | - | - | - | 41 | - | 41 | 128 | 169 | - | 220 | - | 220 | 266 |
| Maine | 6 | 4 | - | - | - | 55 | - | 55 | 66 | 121 | - | 211 | - | 211 | 170 |
| Maryland | 16 | 9 | 8 | 2 | 10 | 33 | - | 43 | 206 | 249 | 124 | 203 | - | 185 | 253 |
| Michigan | 11 | 6 | - | - | - | 13 | - | 13 | 193 | 206 | - | 150 | - | 150 | 287 |
| Minnesota | 9 | 6 | - | - | - | 25 | - | 25 | 222 | 247 | - | 194 | - | 194 | 254 |
| Mississippi | 35 | 21 | - | - | - | 176 | - | 176 | 493 | 669 | - | 220 | - | 220 | 267 |
| Missouri | 119 | 7 | - | - | - | 293 | 3 | 296 | 204 | 500 | - | 171 | 160 | 170 | 289 |
| Montana | 8 | 3 | 2 | - | 2 | 12 | - | 14 | 29 | 43 | 209 | 78 | - | 97 | 307 |
| Nebraska | 4 | 3 | - | - | - | 8 | - | 8 | 3 | 11 | - | 245 | - | 245 | 230 |
| New Hampshire | 4 | - | - | - | - | 6 | - | 6 | - | 6 | - | 245 | - | 245 | - |
| New Jersey | 18 | 9 | - | - | - | 109 | - | 109 | 122 | 231 | - | 240 | - | 240 | 267 |
| New Mexico | 7 | 2 | - | - | - | 10 | - | 10 | (2/) | 10 | - | 115 | - | 115 | (2/) |
| New York | 21 | 12 | - | - | - | 155 | - | 155 | 428 | 583 | - | 182 | - | 182 | 246 |
| North Carolina | 35 | 25 | - | - | - | 130 | - | 130 | 991 | 1,121 | - | 222 | - | 222 | 226 |
| North Dakota | 5 | 2 | - | - | - | 8 | - | 8 | (2/) | 8 | - | 24 | - | 24 | (2/) |
| Ohio | 133 | 45 | 122 | 24 | 146 | 400 | 1 | 547 | 1,414 | 1,961 | 244 | 212 | 68 | 220 | 253 |
| Oklahoma | 17 | 5 | - | - | - | 109 | - | 109 | 145 | 254 | - | 212 | - | 212 | 219 |
| Oregon | 14 | 6 | - | - | - | 29 | - | 29 | 69 | 98 | - | 135 | - | 135 | 217 |
| Pennsylvania | 122 | 39 | 142 | 37 | 179 | 478 | - | 657 | 1,096 | 1,753 | 203 | 235 | - | 226 | 257 |
| South Carolina | 38 | 17 | - | - | - | 143 | - | 143 | 634 | 777 | - | 224 | - | 224 | 266 |
| South Dakota | 3 | 3 | - | - | - | 28 | - | 28 | 83 | 111 | - | 205 | - | 205 | 294 |
| Tennessee | 18 | 12 | - | - | - | 125 | - | 125 | 243 | 368 | - | 228 | - | 228 | 276 |
| Texas | 95 | 39 | 5 | - | 5 | 299 | - | 304 | 800 | 1,104 | 190 | 225 | - | 225 | 259 |
| Utah | 24 | 4 | 66 | 1 | 67 | 84 | - | 151 | 20 | 171 | 272 | 133 | - | 195 | 277 |
| Virginia | 17 | 6 | - | - | - | 64 | - | 64 | 279 | 343 | - | 215 | - | 215 | 271 |
| Washington | 16 | 1 | - | - | - | 30 | - | 30 | 3 | 33 | - | 66 | - | 66 | 141 |
| West Virginia | 10 | 9 | 59 | 8 | 67 | 12 | - | 79 | 397 | 476 | 225 | 224 | - | 225 | 229 |
| Wisconsin | 5 | 3 | - | - | - | 10 | - | 10 | 94 | 104 | - | 42 | - | 42 | 132 |
| Wyoming | 17 | 12 | - | - | - | 120 | - | 120 | 223 | 343 | - | 230 | - | 230 | 265 |
| Other States 3/ and/or combined 2/ | 9 | 3 | 4 | 1 | 5 | 18 | - | 23 | 117 | 140 | 100 | 201 | - | 179 | 256 |
| Total or average | 1,303 | 522 | 554 | 114 | 668 | 4,767 | 15 | 5,450 | 15,250 | 20,700 | 229 | 210 | 223 | 212 | 261 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Delaware with 1 operation, Hawaii with 1, Massachusetts with 4, Nevada with 4, and Vermont with 1.

TABLE B-14. - Injury experience and employment data by general work location at clay mines and mills in the United States, by State, 1964 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | 4,709 | 2,246 | 6,955 | 20,993 | - | 27,948 | 180,326 | 208,274 | 36,422 | 16,724 | 53,146 | 167,935 | - | 221,081 | 1,456,346 | 1,677,427 |
| Arizona | - | - | - | 5,611 | - | 5,611 | 770 | 6,381 | - | - | - | 44,884 | - | 44,884 | 6,160 | 51,044 |
| Arkansas | - | - | - | 7,679 | - | 7,679 | 59,477 | 67,156 | - | - | - | 61,458 | - | 61,458 | 475,804 | 537,262 |
| California | 19,935 | 4,858 | 24,793 | 30,437 | - | 55,230 | 131,963 | 187,193 | 159,482 | 38,864 | 198,346 | 244,600 | - | 442,946 | 1,073,709 | 1,516,655 |
| Colorado | 4,630 | 888 | 5,518 | 15,699 | - | 21,217 | 17,188 | 38,405 | 37,246 | 7,104 | 44,350 | 122,589 | - | 166,939 | 136,066 | 303,005 |
| Connecticut | - | - | - | 3,831 | - | 3,831 | 8,128 | 11,959 | - | - | - | 29,638 | - | 29,638 | 48,768 | 78,406 |
| Florida | - | - | - | 21,129 | 520 | 21,649 | 64,123 | 85,772 | - | - | - | 170,900 | 4,160 | 175,060 | 524,224 | 699,284 |
| Georgia | - | - | - | 188,500 | - | 188,500 | 853,011 | 1,041,511 | - | - | - | 1,514,713 | - | 1,514,713 | 6,824,106 | 8,338,819 |
| Idaho | - | - | - | 4,514 | - | 4,514 | 11,733 | 16,247 | - | - | - | 36,118 | - | 36,118 | 93,870 | 129,988 |
| Illinois | 1,764 | 504 | 2,268 | 19,748 | - | 22,016 | 181,922 | 203,938 | 14,112 | 4,032 | 18,144 | 162,267 | - | 180,411 | 1,456,893 | 1,637,304 |
| Indiana | 160 | - | 160 | 10,974 | - | 11,134 | 93,312 | 104,446 | 1,120 | - | 1,120 | 88,015 | - | 89,135 | 746,267 | 835,402 |
| Iowa | - | - | - | 17,371 | - | 17,371 | 115,803 | 133,174 | - | - | - | 139,247 | - | 139,247 | 937,712 | 1,076,959 |
| Kansas | - | - | - | 7,860 | - | 7,860 | 36,155 | 44,015 | - | - | - | 63,704 | - | 63,704 | 289,603 | 353,307 |
| Kentucky | 4,138 | 612 | 4,750 | 14,829 | 2,281 | 21,860 | 27,991 | 49,851 | 33,100 | 4,896 | 37,996 | 119,838 | 18,244 | 176,078 | 224,649 | 400,727 |
| Louisiana | - | - | - | 9,029 | - | 9,029 | 34,069 | 43,098 | - | - | - | 77,606 | - | 77,606 | 280,414 | 358,020 |
| Maine | - | - | - | 11,621 | - | 11,621 | 11,209 | 22,830 | - | - | - | 92,976 | - | 92,976 | 89,432 | 182,408 |
| Maryland | 992 | 248 | 1,240 | 6,706 | - | 7,946 | 52,119 | 60,065 | 7,936 | 1,984 | 9,920 | 55,320 | - | 65,240 | 422,301 | 487,541 |
| Michigan | - | - | - | 1,944 | - | 1,944 | 55,462 | 57,406 | - | - | - | 15,557 | - | 15,557 | 443,948 | 459,505 |
| Minnesota | - | - | - | 4,849 | - | 4,849 | 56,425 | 61,274 | - | - | - | 38,790 | - | 38,790 | 451,405 | 490,195 |
| Mississippi | - | - | - | 38,730 | - | 38,730 | 131,466 | 170,196 | - | - | - | 312,005 | - | 312,005 | 1,053,371 | 1,365,376 |
| Missouri | - | - | - | 49,981 | 481 | 50,462 | 59,025 | 109,487 | - | - | - | 403,540 | 3,848 | 407,388 | 472,207 | 879,595 |
| Montana | 418 | - | 418 | 934 | - | 1,352 | 8,913 | 10,265 | 3,343 | - | 3,343 | 7,469 | - | 10,812 | 71,298 | 82,110 |
| Nebraska | - | - | - | 1,960 | - | 1,960 | 690 | 2,650 | - | - | - | 15,380 | - | 15,380 | 5,220 | 20,600 |
| New Hampshire | - | - | - | 1,469 | - | 1,469 | - | 1,469 | - | - | - | 11,752 | - | 11,752 | - | 11,752 |
| New Jersey | - | - | - | 26,183 | - | 26,183 | 32,623 | 58,806 | - | - | - | 209,706 | - | 209,706 | 260,980 | 470,686 |
| New Mexico | - | - | - | 1,153 | - | 1,153 | (2/) | 1,153 | - | - | - | 9,223 | - | 9,223 | (2/) | 9,223 |
| New York | - | - | - | 28,198 | - | 28,198 | 105,287 | 133,485 | - | - | - | 225,108 | - | 225,108 | 846,697 | 1,071,805 |
| North Carolina | - | - | - | 28,842 | - | 28,842 | 223,979 | 252,821 | - | - | - | 232,870 | - | 232,870 | 1,726,426 | 1,959,296 |
| North Dakota | - | - | - | 192 | - | 192 | (2/) | 192 | - | - | - | 1,624 | - | 1,624 | (2/) | 1,624 |
| Ohio | 29,629 | 6,065 | 35,694 | 84,781 | 68 | 120,543 | 357,887 | 478,430 | 236,738 | 48,515 | 285,253 | 676,805 | 544 | 962,602 | 2,867,254 | 3,829,856 |
| Oklahoma | - | - | - | 23,059 | - | 23,059 | 31,787 | 54,846 | - | - | - | 183,121 | - | 183,121 | 254,207 | 437,328 |
| Oregon | - | - | - | 3,915 | - | 3,915 | 14,962 | 18,877 | - | - | - | 31,786 | - | 31,786 | 119,676 | 151,462 |
| Pennsylvania | 28,504 | 7,829 | 36,333 | 112,296 | - | 148,629 | 282,198 | 430,827 | 225,733 | 58,395 | 284,128 | 935,834 | - | 1,219,962 | 2,259,315 | 3,479,277 |
| South Carolina | - | - | - | 32,051 | - | 32,051 | 168,637 | 200,688 | - | - | - | 267,884 | - | 267,884 | 1,390,905 | 1,658,789 |
| South Dakota | - | - | - | 5,740 | - | 5,740 | 24,376 | 30,116 | - | - | - | 50,320 | - | 50,320 | 194,720 | 245,040 |
| Tennessee | - | - | - | 28,557 | - | 28,557 | 67,132 | 95,689 | - | - | - | 241,362 | - | 241,362 | 544,264 | 785,626 |
| Texas | 950 | - | 950 | 67,390 | - | 68,340 | 207,574 | 275,914 | 8,550 | - | 8,550 | 555,759 | - | 564,309 | 1,813,923 | 2,378,232 |
| Utah | 18,058 | 155 | 18,213 | 11,167 | - | 29,380 | 5,539 | 34,919 | 144,465 | 1,247 | 145,712 | 89,337 | - | 235,049 | 44,012 | 279,061 |
| Virginia | - | - | - | 13,768 | - | 13,768 | 75,721 | 89,489 | - | - | - | 113,596 | - | 113,596 | 604,268 | 717,864 |
| Washington | - | - | - | 1,976 | - | 1,976 | 424 | 2,400 | - | - | - | 16,221 | - | 16,221 | 3,493 | 19,714 |
| West Virginia | 13,565 | 1,527 | 15,092 | 2,682 | - | 17,774 | 90,972 | 108,746 | 108,480 | 12,200 | 120,680 | 20,232 | - | 140,912 | 726,961 | 867,873 |
| Wisconsin | - | - | - | 418 | - | 418 | 12,445 | 12,863 | - | - | - | 2,908 | - | 2,908 | 104,054 | 106,962 |
| Wyoming | - | - | - | 27,554 | - | 27,554 | 59,179 | 86,733 | - | - | - | 236,764 | - | 236,764 | 473,430 | 710,194 |
| Other States 3/ and/or combined 2/ | 400 | 100 | 500 | 3,609 | - | 4,109 | 29,976 | 34,085 | 3,200 | 800 | 4,000 | 28,246 | - | 32,246 | 239,785 | 272,031 |
| Total | 127,852 | 25,032 | 152,884 | 999,929 | 3,350 | 1,156,163 | 3,981,978 | 5,138,141 | 1,019,927 | 194,761 | 1,214,688 | 8,125,007 | 26,796 | 9,366,491 | 32,058,143 | 41,424,634 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Delaware with 1 operation, Hawaii with 1, Massachusetts with 4, Nevada with 4, and Vermont with 1.

TABLE B-15. - Injury experience and employment data by general work location at gypsum mines and mills in the United States, by State, 1964

**Injuries — Fatal**

| State | Underground mines: Underground | Underground mines: Surface | Underground mines: Total | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
|---|---|---|---|---|---|---|---|---|
| Arizona | - | - | - | - | - | - | - | - |
| Arkansas | - | - | - | - | - | - | - | - |
| California | - | - | - | - | - | - | - | - |
| Iowa | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - |
| New Mexico | - | - | - | - | - | - | - | - |
| New York | - | - | - | - | - | - | - | - |
| Oklahoma | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | - | - | - |
| Wyoming | - | - | - | - | - | - | - | - |
| Other States 3/ and/or combined 2/ | - | - | - | - | - | - | - | - |
| Total | - | - | - | - | - | - | - | - |

**Injuries — Nonfatal**

| State | Underground mines: Underground | Underground mines: Surface | Underground mines: Total | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
|---|---|---|---|---|---|---|---|---|
| Arizona | - | - | - | - | - | - | (2/) | - |
| Arkansas | - | - | - | 2 | - | 2 | - | 2 |
| California | - | - | - | 8 | - | 8 | 5 | 13 |
| Iowa | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | 1 | - | 1 | 7 | 8 |
| New Mexico | - | - | - | - | - | - | (2/) | - |
| New York | 2 | - | 2 | - | - | 2 | 1 | 3 |
| Oklahoma | - | - | - | 1 | - | 1 | (2/) | 1 |
| Texas | - | - | - | - | - | - | 3 | 3 |
| Wyoming | - | - | - | - | - | - | - | - |
| Other States 3/ and/or combined 2/ | 1 | - | 1 | - | - | 1 | 4 | 5 |
| Total | 3 | - | 3 | 12 | - | 15 | 20 | 35 |

**Frequency rates per million man-hours — Fatal**

| State | Underground mines: Underground | Underground mines: Surface | Underground mines: Total | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
|---|---|---|---|---|---|---|---|---|
| Arizona | - | - | - | - | - | - | - | - |
| Arkansas | - | - | - | - | - | - | - | - |
| California | - | - | - | - | - | - | - | - |
| Iowa | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - |
| New Mexico | - | - | - | - | - | - | - | - |
| New York | - | - | - | - | - | - | - | - |
| Oklahoma | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | - | - | - |
| Wyoming | - | - | - | - | - | - | - | - |
| Other States 3/ and/or combined 2/ | - | - | - | - | - | - | - | - |
| Total or average | - | - | - | - | - | - | - | - |

**Frequency rates per million man-hours — Nonfatal**

| State | Underground mines: Underground | Underground mines: Surface | Underground mines: Total | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
|---|---|---|---|---|---|---|---|---|
| Arizona | - | - | - | - | - | - | (2/) | - |
| Arkansas | - | - | - | 30.73 | - | 30.73 | - | 28.33 |
| California | - | - | - | 37.92 | - | 37.92 | 26.00 | 32.23 |
| Iowa | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | 75.20 | - | 7.49 | 12.01 | 11.17 |
| New Mexico | - | - | - | - | - | - | (2/) | - |
| New York | 7.76 | - | 6.75 | - | - | 6.75 | 1.39 | 2.96 |
| Oklahoma | - | - | - | 7.40 | - | 7.40 | (2/) | 7.40 |
| Texas | - | - | - | - | - | - | 19.29 | 10.18 |
| Wyoming | - | - | - | - | - | - | - | - |
| Other States 3/ and/or combined 2/ | 2.38 | - | 1.93 | - | - | 1.68 | 2.64 | 2.37 |
| Total or average | 3.90 | - | 3.26 | 10.24 | - | 7.17 | 5.77 | 6.30 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Colorado with 6 operations; Indiana with 4, Kansas with 4, Montana with 4, Ohio with 4, Utah with 4, and Virginia with 3.

TABLE B-15. Injury experience and employment data by general work location at gypsum mines and mills in the United States, by State, 1964 - Continued

| State | Severity rates per million man-hours | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | 169 | - | 169 | - | 156 |
| California | - | - | - | - | - | - | - | - | - | - | - | 649 | - | 649 | 302 | 484 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | 135 | - | 135 | 146 | 144 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (2/) | - |
| New York | - | - | - | - | - | - | - | - | 1,510 | - | 1,313 | - | - | 1,313 | 6 | 389 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 133 | - | 133 | (2/) | 133 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 38,863 | 20,510 |
| Wyoming | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 3/ and/or combined 2/ | - | - | - | - | - | - | - | - | 140 | - | 114 | - | - | 99 | 42 | 58 |
| Total or average | - | - | - | - | - | - | - | - | 582 | - | 487 | 157 | - | 302 | 1,804 | 1,239 |

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Arizona | 6 | 2 | 1 | - | 1 | 23 | - | 24 | (2/) | 24 | 96 | 237 | - | 232 | (2/) |
| Arkansas | 4 | 1 | - | - | - | 31 | - | 31 | 3 | 34 | - | 262 | - | 262 | 230 |
| California | 9 | 7 | - | - | - | 102 | - | 102 | 98 | 200 | - | 248 | - | 248 | 344 |
| Iowa | 5 | 5 | 23 | 2 | 25 | 77 | - | 102 | 60 | 162 | 251 | 278 | - | 271 | 281 |
| Louisiana | 1 | - | - | - | - | 4 | - | 4 | - | 4 | - | 237 | - | 237 | - |
| Michigan | 6 | 4 | 22 | 5 | 27 | 75 | - | 102 | 72 | 174 | 247 | 265 | - | 260 | 257 |
| Nevada | 6 | 3 | 3 | - | 3 | 68 | - | 71 | 243 | 314 | 20 | 244 | - | 234 | 300 |
| New Mexico | 3 | 1 | - | - | - | 10 | - | 10 | (2/) | 10 | - | 194 | - | 194 | (2/) |
| New York | 5 | 3 | 128 | 18 | 146 | - | - | 146 | 323 | 469 | 254 | - | - | 254 | 278 |
| Oklahoma | 11 | 2 | - | - | - | 67 | - | 67 | (2/) | 67 | - | 253 | - | 253 | (2/) |
| Texas | 7 | 5 | - | - | - | 66 | - | 66 | 68 | 134 | - | 264 | - | 264 | 286 |
| Wyoming | 2 | 1 | - | - | - | 6 | - | 6 | 5 | 11 | - | 224 | - | 224 | 261 |
| Other States 3/ and/or combined 2/ | 16 | 13 | 203 | 47 | 250 | 38 | - | 288 | 717 | 1,005 | 258 | 249 | - | 257 | 263 |
| Total or average | 81 | 47 | 380 | 72 | 452 | 567 | - | 1,019 | 1,589 | 2,608 | 254 | 255 | - | 255 | 278 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Colorado with 6 operations, Indiana with 4, Kansas with 4, Montana with 4, Ohio with 4, Utah with 4, and Virginia with 3.

TABLE B-15. - Injury experience and employment data by general work location at gypsum mines and mills in the United States, by State, 1964 - Continued

| State | Man-days worked | | | | | | | | | Man-hours worked | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona---------------------- | 96 | - | 96 | 5,460 | - | 5,556 | (2/) | 5,556 | 770 | - | 770 | 43,674 | - | 44,444 | (2/) | 44,444 |
| Arkansas--------------------- | - | - | - | 8,135 | - | 8,135 | 689 | 8,824 | - | - | - | 65,085 | - | 65,085 | 5,513 | 70,598 |
| California------------------- | - | - | - | 25,326 | - | 25,326 | 33,753 | 59,079 | - | - | - | 210,983 | - | 210,983 | 192,318 | 403,301 |
| Iowa------------------------- | 5,852 | 418 | 6,270 | 21,414 | - | 27,684 | 16,878 | 44,562 | 46,816 | 3,345 | 50,161 | 171,240 | - | 221,401 | 135,023 | 356,424 |
| Louisiana-------------------- | - | - | - | 946 | - | 946 | - | 946 | - | - | - | 7,569 | - | 7,569 | - | 7,569 |
| Michigan--------------------- | 5,548 | 1,124 | 6,672 | 19,862 | - | 26,534 | 18,499 | 45,033 | 44,384 | 8,995 | 53,379 | 163,471 | - | 216,850 | 151,431 | 368,281 |
| Nevada----------------------- | 60 | - | 60 | 16,559 | - | 16,619 | 72,971 | 89,590 | 480 | - | 480 | 132,971 | - | 133,451 | 582,771 | 716,222 |
| New Mexico------------------- | - | - | - | 1,944 | - | 1,944 | (2/) | 1,944 | - | - | - | 15,548 | - | 15,548 | (2/) | 15,548 |
| New York--------------------- | 32,181 | 4,832 | 37,013 | - | - | 37,013 | 89,701 | 126,714 | 257,658 | 38,652 | 296,310 | - | - | 296,310 | 717,555 | 1,013,865 |
| Oklahoma--------------------- | - | - | - | 16,962 | - | 16,962 | (2/) | 16,962 | - | - | - | 135,173 | - | 135,173 | (2/) | 135,173 |
| Texas------------------------ | - | - | - | 17,392 | - | 17,392 | 19,436 | 36,828 | - | - | - | 139,136 | - | 139,136 | 155,495 | 294,631 |
| Wyoming---------------------- | - | - | - | 1,344 | - | 1,344 | 1,305 | 2,649 | - | - | - | 10,749 | - | 10,749 | 11,745 | 22,494 |
| Other States 3/ and/or combined 2/----------------- | 52,221 | 12,373 | 64,594 | 9,466 | - | 74,060 | 188,763 | 262,823 | 420,024 | 98,986 | 519,010 | 75,720 | - | 594,730 | 1,514,707 | 2,109,437 |
| Total------------------- | 95,958 | 18,747 | 114,705 | 144,810 | - | 259,515 | 441,995 | 701,510 | 770,132 | 149,978 | 920,110 | 1,171,319 | - | 2,091,429 | 3,466,558 | 5,557,987 |

1/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.
3/ Includes Colorado with 6 operations, Indiana with 4, Kansas with 4, Montana with 4, Ohio with 4, Utah with 4, and Virginia with 3.

TABLE B-16. - Injury experience and employment data, by general work location at phosphate rock mines and mills in the United States, by State, 1964

| State | Injuries | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arkansas--------------------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida---------------------- | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 23 | 3 | 26 | 23 | 49 |
| Idaho------------------------ | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 7 | 1 | 8 |
| Montana---------------------- | 1 | - | 1 | - | - | 1 | - | 1 | 16 | - | 16 | - | - | 16 | 2 | 18 |
| North Carolina--------------- | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tennessee-------------------- | - | - | - | - | - | - | - | - | - | - | - | 6 | - | 6 | 1 | 7 |
| Other States 1/-------------- | - | - | - | - | - | - | - | - | 36 | - | 36 | 1 | - | 37 | 11 | 48 |
| Total------------------- | 1 | - | 1 | 1 | - | 2 | - | 2 | 52 | - | 52 | 37 | 3 | 92 | 38 | 130 |

1/ Includes Utah with 2 operations, and Wyoming with 4.

TABLE B-16. - Injury experience and employment data by general work location at phosphate rock mines and mills in the United States, by State, 1964 - Continued

| State | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | 0.36 | - | 0.36 | - | 0.14 | - | - | - | 8.39 | 54.59 | 9.30 | 5.50 | 7.02 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 17.46 | - | 17.46 | 2.49 | 9.96 |
| Montana | 1.19 | - | 0.98 | - | - | .98 | - | .71 | 18.97 | - | 15.74 | - | - | 15.74 | 5.21 | 12.86 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 11.20 | - | 11.20 | 3.04 | 8.09 |
| Other States 1/ | - | - | - | - | - | - | - | - | 183.42 | - | 169.03 | 14.50 | - | 130.94 | 64.90 | 106.18 |
| Total or average | .96 | - | .81 | .26 | - | .40 | - | .19 | 50.02 | - | 42.29 | 9.80 | 54.00 | 18.17 | 6.89 | 12.29 |

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arkansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | 2,189 | - | 2,146 | - | 860 | - | - | - | 1,267 | 1,274 | 1,267 | 176 | 613 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 117 | - | 117 | 497 | 308 |
| Montana | 7,114 | - | 5,902 | - | - | 5,902 | - | 4,285 | 806 | - | 669 | - | - | 669 | 11,816 | 3,722 |
| North Carolina | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 648 | - | 648 | 30 | 413 |
| Other States 1/ | - | - | - | - | - | - | - | - | 3,266 | - | 3,010 | 116 | - | 2,297 | 773 | 1,725 |
| Total or average | 5,771 | - | 4,880 | 1,588 | - | 2,370 | - | 1,135 | 1,271 | - | 1,074 | 1,026 | 1,260 | 1,040 | 1,017 | 1,028 |

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Arkansas | 1 | - | - | - | - | 1 | - | 1 | - | 1 | - | 95 | - | 95 | - |
| Florida | 31 | 23 | - | - | - | 1,042 | 25 | 1,067 | 1,615 | 2,682 | - | 327 | 275 | 326 | 324 |
| Idaho | 4 | 4 | - | - | - | 188 | - | 188 | 155 | 343 | - | 260 | - | 260 | 324 |
| Montana | 9 | 3 | 379 | 79 | 458 | - | - | 458 | 141 | 599 | 280 | - | - | 280 | 340 |
| North Carolina | 1 | 1 | - | - | - | 12 | - | 12 | 20 | 32 | - | 310 | - | 310 | 300 |
| Tennessee | 33 | 5 | - | - | - | 258 | - | 258 | 148 | 406 | - | 253 | - | 253 | 277 |
| Other States 1/ | 6 | 3 | 94 | 8 | 102 | 35 | 3 | 140 | 84 | 224 | 261 | 246 | 20 | 252 | 252 |
| Total or average | 85 | 39 | 473 | 87 | 560 | 1,536 | 28 | 2,124 | 2,163 | 4,287 | 277 | 304 | 248 | 296 | 319 |

1/ Includes Utah with 2 operations, and Wyoming with 4.

TABLE B-16. - Injury experience and employment data by general work location at phosphate rock mines and mills in the United States, by State, 1964 - Continued

| State | Man-days worked: Underground mines: Underground | Underground mines: Surface | Underground mines: Total | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
|---|---|---|---|---|---|---|---|---|
| Arkansas | - | - | - | 95 | - | 95 | - | 95 |
| Florida | - | - | - | 340,649 | 6,870 | 347,519 | 523,342 | 870,861 |
| Idaho | - | - | - | 48,953 | - | 48,953 | 50,284 | 99,237 |
| Montana | 106,769 | 21,572 | 128,341 | - | - | 128,341 | 47,939 | 176,280 |
| North Carolina | - | - | - | 3,719 | - | 3,719 | 6,000 | 9,719 |
| Tennessee | - | - | - | 65,339 | - | 65,339 | 40,931 | 106,270 |
| Other States 1/ | 24,534 | 2,088 | 26,622 | 8,624 | 60 | 35,306 | 21,187 | 56,493 |
| Total | 131,303 | 23,660 | 154,963 | 467,379 | 6,930 | 629,272 | 689,683 | 1,318,955 |

| State | Man-hours worked: Underground mines: Underground | Underground mines: Surface | Underground mines: Total | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
|---|---|---|---|---|---|---|---|---|
| Arkansas | - | - | - | 756 | - | 756 | - | 756 |
| Florida | - | - | - | 2,741,242 | 54,960 | 2,796,202 | 4,181,751 | 6,977,953 |
| Idaho | - | - | - | 400,975 | - | 400,975 | 402,276 | 803,251 |
| Montana | 843,356 | 173,278 | 1,016,634 | - | - | 1,016,634 | 383,543 | 1,400,177 |
| North Carolina | - | - | - | 29,748 | - | 29,748 | 48,000 | 77,748 |
| Tennessee | - | - | - | 535,709 | - | 535,709 | 329,117 | 864,826 |
| Other States 1/ | 196,272 | 16,704 | 212,976 | 68,988 | 600 | 282,564 | 169,493 | 452,057 |
| Total | 1,039,628 | 189,982 | 1,229,610 | 3,777,418 | 55,560 | 5,062,588 | 5,514,180 | 10,576,768 |

1/ Includes Utah with 2 operations, and Wyoming with 4.

TABLE B-17. - Injury experience and employment data by general work location at potash mines and mills in the United States, by State, 1964

| State | Injuries | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| New Mexico and Utah---------- | 4 | - | 4 | - | - | 4 | 1 | 5 | 150 | 19 | 169 | - | 2 | 171 | 45 | 216 |

| State | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| New Mexico and Utah---------- | 1.19 | - | 0.75 | - | - | 0.74 | 0.38 | 0.62 | 44.76 | 9.49 | 31.57 | - | 66.14 | 31.76 | 16.88 | 26.83 |

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| New Mexico and Utah---------- | 7,161 | - | 4,483 | - | - | 4,458 | 2,251 | 3,727 | 1,708 | 1,587 | 1,663 | - | 4,729 | 1,680 | 394 | 1,254 |

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| New Mexico and Utah---------- | 13 | 9 | 1,277 | 733 | 2,010 | - | 12 | 2,022 | 1,003 | 3,025 | 333 | - | 315 | 333 | 332 |

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| New Mexico and Utah---------- | 418,929 | 250,275 | 669,204 | - | 3,780 | 672,984 | 333,222 | 1,006,206 | 3,351,440 | 2,002,302 | 5,353,742 | - | 30,240 | 5,383,982 | 2,665,773 | 8,049,755 |

TABLE B-18. - Injury experience and employment data by general work location at salt mines and mills in the United States, by State, 1964

| State | Injuries | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open-pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| California | - | - | - | - | - | - | - | - | - | - | - | 1 | 16 | 17 | 11 | 28 |
| Kansas | - | - | - | - | - | - | - | - | 5 | 1 | 6 | - | 1 | 7 | 22 | 29 |
| Louisiana | - | - | - | - | - | - | - | - | 19 | 12 | 31 | - | - | 31 | 47 | 78 |
| Michigan | - | - | - | - | - | - | - | - | 4 | 4 | 8 | - | 1 | 9 | 20 | 29 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 6 |
| New York | - | 1 | 1 | - | - | 1 | - | 1 | 23 | 15 | 38 | - | - | 38 | 38 | 76 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Ohio | - | - | - | - | - | - | - | - | 10 | 3 | 13 | - | - | 13 | 17 | 30 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | - | - | - | 1 | 3 | 4 | - | 2 | 6 | 13 | 19 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 1/ | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 8 | 9 |
| Total | - | 1 | 1 | - | - | 1 | - | 1 | 62 | 38 | 100 | 1 | 21 | 122 | 183 | 305 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| California | - | - | - | - | - | - | - | - | - | - | - | 32.94 | 54.37 | 52.37 | 14.65 | 26.04 |
| Kansas | - | - | - | - | - | - | - | - | 65.84 | 54.99 | 63.75 | - | 15.74 | 44.40 | 14.64 | 17.46 |
| Louisiana | - | - | - | - | - | - | - | - | 52.47 | 39.86 | 46.75 | - | - | 43.55 | 25.89 | 30.86 |
| Michigan | - | - | - | - | - | - | - | - | 17.58 | 38.43 | 24.12 | - | 37.38 | 25.11 | 8.95 | 11.18 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 65.32 | 50.66 |
| New York | - | 3.37 | 0.98 | - | - | 0.94 | - | 0.44 | 31.93 | 50.53 | 37.36 | - | - | 35.53 | 31.63 | 33.47 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 20.77 | 17.57 |
| Ohio | - | - | - | - | - | - | - | - | 28.76 | 44.68 | 31.34 | - | - | 28.37 | 19.97 | 22.91 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | - | - | - | 16.63 | 22.65 | 20.77 | - | 29.60 | 23.07 | 24.65 | 24.12 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 1/ | - | - | - | - | - | - | - | - | - | - | - | - | 16.94 | 16.94 | 4.14 | 4.52 |
| Total or average | - | 1.09 | .37 | - | - | .29 | - | .07 | 34.56 | 41.32 | 36.85 | 19.74 | 29.04 | 34.98 | 16.30 | 20.72 |

1/ Includes Alabama with 2 operations, Colorado with 2, Hawaii with 1, and West Virginia with 5.

TABLE B-18. - Injury experience and employment data by general work location at salt mines and mills in the United States, by State, 1964 - Continued

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| California | - | - | - | - | - | - | - | - | - | - | - | 66 | 1,478 | 1,346 | 337 | 642 |
| Kansas | - | - | - | - | - | - | - | - | 211 | 1,815 | 521 | - | 47,229 | 19,341 | 2,169 | 3,799 |
| Louisiana | - | - | - | - | - | - | - | - | 8,464 | 1,505 | 5,305 | - | - | 4,943 | 560 | 1,794 |
| Michigan | - | - | - | - | - | - | - | - | 48 | 2,834 | 923 | - | 748 | 910 | 427 | 493 |
| Nevada | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,263 | 979 |
| New York | - | 20,211 | 5,899 | - | - | 5,610 | - | 2,642 | 827 | 3,092 | 1,488 | - | - | 1,416 | 514 | 939 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,994 | 1,687 |
| Ohio | - | - | - | - | - | - | - | - | 331 | 60 | 287 | - | - | 260 | 693 | 541 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Texas | - | - | - | - | - | - | - | - | 50 | 272 | 203 | - | 207 | 204 | 525 | 419 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Other States 1/ | - | - | - | - | - | - | - | - | - | - | - | - | 1,694 | 1,694 | 103 | 151 |
| Total or average | - | 6,523 | 2,211 | - | - | 1,720 | - | 408 | 2,122 | 1,891 | 2,043 | 39 | 4,935 | 2,614 | 657 | 1,121 |

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| California | 16 | 7 | - | - | - | 15 | 141 | 156 | 342 | 498 | - | 253 | 259 | 259 | 277 |
| Kansas | 9 | 8 | 36 | 9 | 45 | - | 24 | 69 | 578 | 647 | 264 | - | 331 | 287 | 326 |
| Louisiana | 16 | 7 | 162 | 139 | 301 | - | 22 | 323 | 853 | 1,176 | 276 | - | 276 | 276 | 266 |
| Michigan | 8 | 7 | 108 | 51 | 159 | - | 13 | 172 | 1,017 | 1,189 | 261 | - | 257 | 260 | 275 |
| Nevada | 1 | - | - | - | - | 2 | - | 2 | - | 2 | - | 30 | - | 30 | - |
| New Mexico | 8 | 8 | - | - | - | 5 | 10 | 15 | 44 | 59 | - | 247 | 209 | 222 | 261 |
| New York | 7 | 5 | 280 | 120 | 400 | - | 25 | 425 | 586 | 1,011 | 283 | - | 261 | 282 | 255 |
| North Dakota | 1 | 1 | - | - | - | - | 3 | 3 | 16 | 19 | - | - | 365 | 365 | 365 |
| Ohio | 21 | 5 | 154 | 30 | 184 | - | 18 | 202 | 375 | 577 | 282 | - | 301 | 284 | 286 |
| Oklahoma | 2 | 1 | - | - | - | - | 3 | 3 | 3 | 6 | - | - | 203 | 203 | 320 |
| Texas | 11 | 5 | 30 | 65 | 95 | - | 28 | 123 | 264 | 387 | 256 | - | 302 | 267 | 250 |
| Utah | 9 | 7 | - | - | - | 9 | 22 | 31 | 119 | 150 | - | 146 | 213 | 194 | 249 |
| Virginia | - | 1 | - | - | - | - | - | - | 11 | 11 | - | - | - | - | 271 |
| Other States 1/ | 8 | 2 | - | - | - | - | 27 | 27 | 662 | 689 | - | - | 282 | 282 | 365 |
| Total or average | 117 | 64 | 770 | 414 | 1,184 | 31 | 336 | 1,551 | 4,870 | 6,421 | 275 | 207 | 269 | 273 | 288 |

1/ Includes Alabama with 2 operations, Colorado with 2, Hawaii with 1, and West Virginia with 5.

TABLE B-18. - Injury experience and employment data by general work location at salt mines and mills in the United States, by State, 1964 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| California | - | - | - | 3,795 | 36,570 | 40,365 | 94,852 | 135,217 | - | - | - | 30,360 | 294,279 | 324,639 | 750,818 | 1,075,457 |
| Kansas | 9,492 | 2,393 | 11,885 | - | 7,940 | 19,825 | 188,300 | 208,125 | 75,937 | 18,184 | 94,121 | - | 63,520 | 157,641 | 1,503,206 | 1,660,847 |
| Louisiana | 45,260 | 37,897 | 83,157 | - | 6,075 | 89,232 | 226,940 | 316,172 | 362,127 | 301,039 | 663,166 | - | 48,587 | 711,753 | 1,815,554 | 2,527,307 |
| Michigan | 28,449 | 13,011 | 41,460 | - | 3,342 | 44,802 | 279,484 | 324,286 | 227,593 | 104,087 | 331,680 | - | 26,749 | 358,429 | 2,235,473 | 2,593,902 |
| Nevada | - | - | - | 60 | - | 60 | - | 60 | - | - | - | 480 | - | 480 | - | 480 |
| New Mexico | - | - | - | 1,234 | 2,089 | 3,323 | 11,482 | 14,805 | - | - | - | 9,872 | 16,715 | 26,587 | 91,851 | 118,438 |
| New York | 79,407 | 33,840 | 113,247 | - | 6,531 | 119,778 | 149,186 | 218,964 | 720,317 | 296,868 | 1,017,185 | - | 52,247 | 1,069,432 | 1,201,317 | 2,270,749 |
| North Dakota | - | - | - | - | 1,095 | 1,095 | 6,018 | 7,113 | - | - | - | - | 8,760 | 8,760 | 48,146 | 56,906 |
| Ohio | 43,463 | 8,394 | 51,857 | - | 5,425 | 57,282 | 107,123 | 164,405 | 347,704 | 67,149 | 414,853 | - | 43,376 | 458,229 | 851,482 | 1,309,711 |
| Oklahoma | - | - | - | - | 610 | 610 | 960 | 1,570 | - | - | - | - | 4,880 | 4,880 | 9,600 | 14,480 |
| Texas | 7,515 | 16,828 | 24,343 | - | 8,446 | 32,789 | 65,933 | 98,722 | 60,120 | 132,432 | 192,552 | - | 67,569 | 260,121 | 527,459 | 787,580 |
| Utah | - | - | - | 1,318 | 4,684 | 6,002 | 29,613 | 35,615 | - | - | - | 9,940 | 37,476 | 47,416 | 236,898 | 284,314 |
| Virginia | - | - | - | - | - | - | 2,986 | 2,986 | - | - | - | - | - | - | 23,892 | 23,892 |
| Other States 1/ | - | - | - | - | 7,617 | 7,617 | 241,740 | 249,357 | - | - | - | - | 59,046 | 59,046 | 1,933,620 | 1,992,666 |
| Total | 213,586 | 112,363 | 325,949 | 6,407 | 90,424 | 422,780 | 1,404,617 | 1,827,397 | 1,793,798 | 919,759 | 2,713,557 | 50,652 | 723,204 | 3,487,413 | 11,229,316 | 14,716,729 |

1/ Includes Alabama with 2 operations, Colorado with 2, Hawaii with 1, and West Virginia with 5.

TABLE B-19. - Injury experience and employment data by general work location at sulfur mines and mills in the United States, by State, 1964

| State | Injuries | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | 12 | 12 | - | 12 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | - | 33 | 33 | - | 33 |
| Other States 1/ | - | - | - | - | - | - | - | - | 8 | - | 8 | - | - | 8 | - | 8 |
| Total | - | - | - | - | - | - | - | - | 8 | - | 8 | - | 45 | 53 | - | 53 |
| | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | 7.14 | 7.14 | - | 7.14 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | - | 14.03 | 14.03 | - | 14.03 |
| Other States 1/ | - | - | - | - | - | - | - | - | 133.12 | - | 109.02 | - | - | 108.63 | - | 84.66 |
| Total or average | - | - | - | - | - | - | - | - | 133.12 | - | 109.02 | - | 11.16 | 12.91 | - | 12.84 |

1/ Includes California with 1 operation, Colorado with 2, and Nevada with 2.

TABLE B-19.- Injury experience and employment data by general work location at sulfur mines and mills in the United States, by State, 1964 - Continued

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | 271 | 271 | - | 271 |
| Texas | - | - | - | - | - | - | - | - | - | - | - | - | 386 | 386 | - | 386 |
| Other States 1/ | - | - | - | - | - | - | - | - | 5,841 | - | 4,783 | - | - | 4,766 | - | 3,715 |
| Total or average | - | - | - | - | - | - | - | - | 5,841 | - | 4,783 | - | 338 | 418 | - | 416 |

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Louisiana | 4 | - | - | - | - | - | 470 | 470 | - | 470 | - | - | 365 | 365 | - |
| Texas | 6 | - | - | - | - | - | 808 | 808 | - | 808 | - | - | 365 | 365 | - |
| Other States 1/ | 3 | 2 | 24 | 5 | 29 | 5 | 1 | 35 | 11 | 46 | 316 | 2 | 23 | 263 | 237 |
| Total or average | 13 | 2 | 24 | 5 | 29 | 5 | 1,279 | 1,313 | 11 | 1,324 | 316 | 2 | 365 | 363 | 237 |

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Louisiana | - | - | - | - | 171,905 | 171,905 | - | 171,905 | - | - | - | - | 1,681,283 | 1,681,283 | - | 1,681,283 |
| Texas | - | - | - | - | 294,912 | 294,912 | - | 294,912 | - | - | - | - | 2,351,341 | 2,351,341 | - | 2,351,341 |
| Other States 1/ | 7,512 | 1,661 | 9,173 | 10 | 23 | 9,206 | 2,606 | 11,812 | 60,096 | 13,285 | 73,381 | 80 | 184 | 73,645 | 20,846 | 94,491 |
| Total | 7,512 | 1,661 | 9,173 | 10 | 466,840 | 476,023 | 2,606 | 478,629 | 60,096 | 13,285 | 73,381 | 80 | 4,032,808 | 4,106,269 | 20,846 | 4,127,115 |

1/ Includes California with 1 operation, Colorado with 2, and Nevada with 2.

TABLE B-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1964

| State | Injuries | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 2/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 2 | - | 5 | 1 | 6 |
| Arkansas | - | - | - | - | - | - | - | - | 27 | - | 27 | 1 | - | 28 | 14 | 42 |
| California | 1 | - | 1 | - | - | 1 | - | 1 | 21 | - | 21 | 9 | 4 | 34 | 50 | 84 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| Georgia | - | - | - | 2 | - | 2 | - | 2 | 3 | - | 3 | 5 | - | 8 | 8 | 16 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 1 | 4 | 5 | - | 5 |
| Illinois | - | - | - | - | - | - | 1 | 1 | 11 | - | 11 | - | - | 11 | 11 | 22 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| Kentucky | - | - | - | - | - | - | - | - | 20 | - | 20 | - | - | 20 | 3 | 23 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 25 | 25 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | (3/) | 1 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 21 | 22 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 5 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 11 | - | 11 | 24 | 35 |
| Montana | - | - | - | - | - | - | - | - | 2 | - | 2 | 4 | - | 6 | 13 | 19 |
| Nevada | - | - | - | - | - | - | - | - | 1 | - | 1 | 4 | - | 5 | 25 | 30 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | (3/) | 1 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 6 | 8 |
| New York | - | - | - | - | - | - | - | - | 13 | 3 | 16 | 1 | - | 17 | 4 | 21 |
| North Carolina | - | - | - | 1 | - | 1 | - | 1 | 3 | - | 3 | 7 | - | 10 | 11 | 21 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | (3/) | 1 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 4 | 7 |
| South Dakota | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 1 | - | 4 | (3/) | 4 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 18 | 20 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vermont | - | - | - | - | - | - | - | - | 6 | 2 | 8 | - | - | 8 | 9 | 17 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 12 | 16 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| Wyoming | - | - | - | - | - | - | - | - | 2 | 1 | 3 | - | 1 | 4 | 2 | 6 |
| Other States 4/ and/or combined 3/ | - | - | - | - | - | - | - | - | 1 | - | 1 | 5 | - | 6 | 16 | 22 |
| Total | 1 | - | 1 | 3 | - | 4 | 1 | 5 | 114 | 8 | 122 | 67 | 10 | 199 | 283 | 482 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
3/ Combined to avoid disclosure of individual company data.
4/ Includes Alabama with 4 operations, Connecticut with 4, Florida with 2, Nebraska with 2, New Jersey with 4, North Dakota with 1, Ohio with 2, and Oklahoma with 3.

TABLE B-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1964 - Continued

| State | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 2/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona | - | - | - | - | - | - | - | - | 17.07 | 37.55 | 20.86 | 17.97 | - | 19.60 | 7.99 | 15.78 |
| Arkansas | - | - | - | - | - | - | - | - | 275.74 | - | 222.91 | 17.22 | - | 156.24 | 30.95 | 66.51 |
| California | 5.37 | - | 4.88 | - | - | 0.70 | - | 0.13 | 112.71 | - | 102.39 | 12.19 | 8.08 | 23.64 | 8.20 | 11.15 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | 47.11 | - | 26.77 | - | 16.39 |
| Georgia | - | - | - | 13.89 | - | 11.26 | - | 3.94 | 113.64 | - | 89.29 | 34.73 | - | 45.06 | 24.28 | 31.56 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 56.89 | 13.45 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 53.30 | 416.67 | 176.29 | - | 121.42 |
| Illinois | - | - | - | - | - | - | 2.09 | 1.04 | 26.39 | - | 22.92 | - | - | 22.86 | 22.95 | 22.90 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| Kentucky | - | - | - | - | - | - | - | - | 92.12 | - | 79.07 | - | - | 77.77 | 32.93 | 66.04 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 96.62 | 96.62 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 80.78 | - | 80.78 | (3/) | 80.78 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | 6.27 | 6.27 | 10.95 | 10.59 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8.06 | 8.06 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 28.25 | - | 28.25 | 41.26 | 36.04 |
| Montana | - | - | - | - | - | - | - | - | 144.18 | - | 123.58 | 21.71 | - | 29.93 | 84.02 | 53.49 |
| Nevada | - | - | - | - | - | - | - | - | 49.14 | - | 49.14 | 18.10 | - | 20.72 | 29.02 | 27.21 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 32.47 | - | 32.47 | (3/) | 32.47 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | 26.36 | - | 26.31 | 51.25 | 41.43 |
| New York | - | - | - | - | - | - | - | - | 62.45 | 110.42 | 67.99 | 21.34 | - | 60.24 | 6.92 | 24.41 |
| North Carolina | - | - | - | 3.32 | - | 2.85 | - | 99 | 103.14 | - | 69.10 | 23.21 | - | 28.45 | 16.64 | 20.74 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 19.79 | - | 19.79 | (3/) | 19.79 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 20.35 | - | 20.35 | 15.34 | 17.15 |
| South Dakota | - | - | - | - | - | - | - | - | 99.59 | 200.32 | 119.64 | 11.26 | - | 35.12 | (3/) | 35.12 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 25.48 | - | 21.46 | 38.23 | 35.46 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vermont | - | - | - | - | - | - | - | - | 81.61 | 164.88 | 93.40 | - | - | 36.56 | 19.92 | 25.35 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 29.96 | - | 28.49 | 41.24 | 37.09 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 16.55 | - | 16.55 | - | 7.68 |
| Wyoming | - | - | - | - | - | - | - | - | 5.05 | 11.41 | 6.20 | - | 5.95 | 6.11 | 3.18 | 4.67 |
| Other States 4/ and/or combined 3/ | - | - | - | - | - | - | - | - | 50.08 | - | 40.06 | 26.59 | - | 27.00 | 16.79 | 18.72 |
| Total or average | .54 | - | .46 | .88 | - | .62 | .06 | .22 | 61.36 | 23.77 | 55.60 | 19.58 | 11.59 | 30.72 | 17.14 | 20.97 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
3/ Combined to avoid disclosure of individual company data.
4/ Includes Alabama with 4 operations, Connecticut with 4, Florida with 2, Nebraska with 2, New Jersey with 4, North Dakota with 1, Ohio with 2, and Oklahoma with 3.

TABLE B-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1964 - Continued

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 2/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona | - | - | - | - | - | - | - | - | 1,204 | 751 | 1,120 | 1,051 | - | 1,090 | 8 | 734 |
| Arkansas | - | - | - | - | - | - | - | - | 2,390 | - | 1,932 | 275 | - | 1,395 | 1,282 | 1,314 |
| California | 32,201 | - | 29,254 | - | - | 4,172 | - | 796 | 1,986 | - | 1,804 | 463 | 804 | 772 | 255 | 354 |
| Colorado | - | - | - | - | - | - | - | - | - | - | - | 4,806 | - | 2,730 | - | 1,672 |
| Georgia | - | - | - | 83,359 | - | 67,585 | - | 23,667 | 1,553 | - | 1,220 | 9,183 | - | 7,676 | 355 | 2,919 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 512 | 121 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 5,437 | 11,667 | 7,545 | - | 5,197 |
| Illinois | - | - | - | - | - | - | 12,518 | 6,246 | 895 | - | 777 | - | - | 775 | 267 | 522 |
| Indiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Kansas | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| Kentucky | - | - | - | - | - | - | - | - | 1,216 | - | 1,044 | - | - | 1,027 | 845 | 979 |
| Louisiana | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,959 | 1,959 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Maryland | - | - | - | - | - | - | - | - | - | - | - | 5,331 | - | 5,331 | (3/) | 5,331 |
| Michigan | - | - | - | - | - | - | - | - | - | - | - | - | 188 | 188 | 594 | 563 |
| Minnesota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 95 | 95 |
| Missouri | - | - | - | - | - | - | - | - | - | - | - | 1,043 | - | 1,043 | 1,038 | 1,040 |
| Montana | - | - | - | - | - | - | - | - | 216 | - | 185 | 157 | - | 160 | 1,713 | 836 |
| Nevada | - | - | - | - | - | - | - | - | 4,816 | - | 4,816 | 290 | - | 671 | 2,642 | 2,211 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 2,273 | - | 2,273 | (3/) | 2,273 |
| New Mexico | - | - | - | - | - | - | - | - | - | - | - | 2,596 | - | 2,591 | 111 | 1,088 |
| New York | - | - | - | - | - | - | - | - | 6,024 | 11,926 | 6,706 | 683 | - | 5,705 | 396 | 2,137 |
| North Carolina | - | - | - | 19,896 | - | 17,071 | - | 5,925 | 6,704 | - | 4,491 | 627 | - | 1,093 | 7,162 | 5,055 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 1,227 | - | 1,227 | (3/) | 1,227 |
| Pennsylvania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 380 | - | 380 | 153 | 235 |
| South Dakota | - | - | - | - | - | - | - | - | 13,793 | 1,002 | 11,246 | 203 | - | 2,634 | (3/) | 2,634 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | - | - | - | (3/) | - |
| Texas | - | - | - | - | - | - | - | - | - | - | - | 166 | - | 140 | 1,529 | 1,299 |
| Utah | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vermont | - | - | - | - | - | - | - | - | 558 | 742 | 584 | - | - | 228 | 232 | 231 |
| Virginia | - | - | - | - | - | - | - | - | - | - | - | 1,116 | - | 1,061 | 375 | 598 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 17 | - | 17 | - | 8 |
| Wyoming | - | - | - | - | - | - | - | - | 649 | 856 | 687 | - | 6 | 508 | 148 | 332 |
| Other States 4/ and/or combined 3/ | - | - | - | - | - | - | - | - | 1,002 | - | 801 | 2,409 | - | 2,129 | 211 | 574 |
| Total or average | 3,230 | - | 2,734 | 5,261 | - | 3,705 | 363 | 1,305 | 1,921 | 1,287 | 1,823 | 1,112 | 627 | 1,289 | 822 | 953 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite pumice, sodium compounds, talc, soapstone and pyrophllite, vermiculite, and wollastonite.
2/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
3/ Combined to avoid disclosure of individual company data.
4/ Includes Alabama with 4 operations, Connecticut with 4, Florida with 2, Nebraska with 2, New Jersey with 4, North Dakota with 1, Ohio with 2, and Oklahoma with 3.

TABLE B-20.- Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1964 - Continued

| State | Active operations | | Men employed | | | | | | | | Average days active | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mines | Mills | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 2/ | Underground mines | Open pit mines | Other surface mining | Total mining activities | Mills |
| | | | Underground | Surface | Total | | | | | | | | | | |
| Arizona | 22 | 8 | 75 | 17 | 92 | 78 | - | 170 | 68 | 238 | 195 | 179 | - | 188 | 230 |
| Arkansas | 11 | 8 | 59 | 14 | 73 | 39 | - | 112 | 212 | 324 | 207 | 186 | - | 200 | 267 |
| California | 123 | 46 | 93 | 10 | 103 | 394 | 197 | 694 | 2,497 | 3,191 | 249 | 234 | 309 | 258 | 305 |
| Colorado | 17 | 3 | 6 | 3 | 9 | 28 | 1 | 38 | 19 | 57 | 223 | 95 | 10 | 123 | 156 |
| Georgia | 16 | 5 | 11 | 3 | 14 | 80 | - | 94 | 134 | 228 | 240 | 222 | - | 225 | 290 |
| Hawaii | 23 | 3 | - | - | - | 71 | - | 71 | 17 | 88 | - | 98 | - | 98 | 129 |
| Idaho | 9 | 3 | - | - | - | 23 | 8 | 31 | 8 | 39 | - | 102 | 150 | 114 | 200 |
| Illinois | 21 | 7 | 220 | 35 | 255 | 3 | - | 258 | 238 | 496 | 235 | 60 | - | 233 | 252 |
| Indiana | 2 | 1 | - | - | - | 1 | - | 1 | 1 | 2 | - | 85 | - | 85 | 165 |
| Kansas | 4 | 1 | - | - | - | 5 | - | 5 | (3/) | 5 | - | 75 | - | 75 | (3/) |
| Kentucky | 4 | 4 | 101 | 19 | 120 | 3 | - | 123 | 40 | 163 | 263 | 176 | - | 261 | 285 |
| Louisiana | - | 4 | - | - | - | - | - | - | 123 | 123 | - | - | - | - | 263 |
| Maine | 11 | - | 2 | - | 2 | 9 | - | 11 | - | 11 | 25 | 137 | - | 117 | - |
| Maryland | 3 | 1 | - | - | - | 6 | - | 6 | (3/) | 6 | - | 246 | - | 246 | (3/) |
| Michigan | 22 | 6 | - | - | - | - | 70 | 70 | 664 | 734 | - | - | 287 | 287 | 363 |
| Minnesota | 1 | - | - | - | - | 2 | - | 2 | - | 2 | - | 187 | - | 187 | - |
| Mississippi | - | 1 | - | - | - | - | - | - | 303 | 303 | - | - | - | - | 256 |
| Missouri | 17 | 18 | - | - | - | 213 | - | 213 | 272 | 485 | - | 228 | - | 228 | 266 |
| Montana | 11 | 5 | 6 | 1 | 7 | 96 | - | 103 | 80 | 183 | 289 | 240 | - | 243 | 242 |
| Nevada | 44 | 15 | 19 | - | 19 | 122 | - | 141 | 391 | 532 | 138 | 216 | - | 206 | 275 |
| New Hampshire | 4 | 1 | - | - | - | 34 | - | 34 | (3/) | 34 | - | 113 | - | 113 | (3/) |
| New Mexico | 24 | 9 | - | 2 | 2 | 51 | - | 53 | 56 | 109 | 9 | 189 | - | 182 | 261 |
| New York | 11 | 12 | 93 | 12 | 105 | 32 | - | 137 | 264 | 401 | 276 | 183 | - | 254 | 274 |
| North Carolina | 59 | 14 | 20 | 8 | 28 | 188 | 3 | 219 | 305 | 524 | 194 | 199 | 262 | 199 | 271 |
| Oregon | 10 | 2 | - | - | - | 30 | - | 30 | (3/) | 30 | - | 211 | - | 211 | (3/) |
| Pennsylvania | 6 | 2 | - | - | - | 17 | - | 17 | (3/) | 17 | - | 140 | - | 140 | (3/) |
| South Carolina | 8 | 7 | - | - | - | 60 | - | 60 | 111 | 171 | - | 271 | - | 271 | 285 |
| South Dakota | 24 | 2 | 9 | 2 | 11 | 64 | - | 75 | (3/) | 75 | 285 | 175 | - | 191 | (3/) |
| Tennessee | 5 | 1 | - | - | - | 41 | - | 41 | (3/) | 41 | - | 229 | - | 229 | (3/) |
| Texas | 12 | 10 | - | - | - | 44 | 7 | 51 | 187 | 238 | - | 223 | 262 | 228 | 312 |
| Utah | 4 | 1 | - | - | - | 7 | - | 7 | 1 | 8 | - | 173 | - | 173 | 10 |
| Vermont | 4 | 5 | 30 | 5 | 35 | 67 | - | 102 | 199 | 301 | 298 | 248 | - | 265 | 283 |
| Virginia | 9 | 8 | 4 | 1 | 5 | 74 | - | 79 | 138 | 217 | 172 | 229 | - | 226 | 272 |
| Washington | 17 | 5 | - | - | - | 61 | - | 61 | 53 | 114 | - | 122 | - | 122 | 164 |
| Wyoming | 6 | 2 | 199 | 44 | 243 | 4 | 151 | 398 | 308 | 706 | 248 | 112 | 139 | 205 | 255 |
| Other States 4/ and/or combined 3/ | 14 | 8 | 8 | 2 | 10 | 86 | 5 | 101 | 392 | 493 | 312 | 270 | 230 | 272 | 298 |
| Total or average | 578 | 228 | 955 | 178 | 1,133 | 2,033 | 442 | 3,608 | 7,081 | 10,689 | 241 | 208 | 242 | 223 | 291 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
3/ Combined to avoid disclosure of individual company data.
4/ Includes Alabama with 4 operations, Connecticut with 4, Florida with 2, Nebraska with 2, New Jersey with 4, North Dakota with 1, Ohio with 2, and Oklahoma with 3.

TABLE B-20. - Injury experience and employment data by general work location at miscellaneous nonmetal 1/ mines and mills in the United States, by State, 1964 - Continued

| State | Man-days worked | | | | | | | | Man-hours worked | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 2/ | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total 2/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Arizona | 14,645 | 3,329 | 17,974 | 13,989 | - | 31,963 | 15,645 | 47,608 | 117,158 | 26,632 | 143,790 | 111,302 | - | 255,092 | 125,124 | 380,216 |
| Arkansas | 12,240 | 2,901 | 15,141 | 7,249 | - | 22,390 | 56,540 | 78,930 | 97,920 | 23,207 | 121,127 | 58,082 | - | 179,209 | 452,310 | 631,519 |
| California | 23,323 | 2,356 | 25,679 | 92,114 | 60,965 | 178,758 | 762,322 | 941,080 | 186,327 | 18,772 | 205,099 | 738,126 | 494,845 | 1,438,070 | 6,095,305 | 7,533,375 |
| Colorado | 1,215 | 792 | 2,007 | 2,650 | 10 | 4,667 | 2,969 | 7,636 | 9,724 | 6,333 | 16,057 | 21,225 | 80 | 37,362 | 23,638 | 61,000 |
| Georgia | 2,640 | 720 | 3,360 | 17,750 | - | 21,110 | 38,809 | 59,919 | 26,400 | 7,200 | 33,600 | 143,955 | - | 177,555 | 329,472 | 507,027 |
| Hawaii | - | - | - | 6,937 | - | 6,937 | 2,197 | 9,134 | - | - | - | 56,786 | - | 56,786 | 17,578 | 74,364 |
| Idaho | - | - | - | 2,346 | 1,200 | 3,546 | 1,602 | 5,148 | - | - | - | 18,762 | 9,600 | 28,362 | 12,818 | 41,180 |
| Illinois | 52,096 | 7,886 | 59,982 | 180 | - | 60,162 | 59,916 | 120,078 | 416,762 | 63,090 | 479,852 | 1,440 | - | 481,292 | 479,328 | 960,620 |
| Indiana | - | - | - | 85 | - | 85 | 165 | 250 | - | - | - | 680 | - | 680 | 1,322 | 2,002 |
| Kansas | - | - | - | 375 | - | 375 | (3/) | 375 | - | - | - | 2,994 | - | 2,994 | (3/) | 2,994 |
| Kentucky | 27,138 | 4,480 | 31,618 | 528 | - | 32,146 | 11,388 | 43,534 | 217,103 | 35,842 | 252,945 | 4,224 | - | 257,169 | 91,113 | 348,282 |
| Louisiana | - | - | - | - | - | - | 32,342 | 32,342 | - | - | - | - | - | - | 258,745 | 258,745 |
| Maine | 50 | - | 50 | 1,235 | - | 1,285 | - | 1,285 | 400 | - | 400 | 10,336 | - | 10,736 | - | 10,736 |
| Maryland | - | - | - | 1,473 | - | 1,473 | (3/) | 1,473 | - | - | - | 12,380 | - | 12,380 | (3/) | 12,380 |
| Michigan | - | - | - | - | 20,100 | 20,100 | 241,084 | 261,184 | - | - | - | - | 159,581 | 159,581 | 1,918,684 | 2,078,265 |
| Minnesota | - | - | - | 373 | - | 373 | - | 373 | - | - | - | 2,983 | - | 2,983 | - | 2,983 |
| Mississippi | - | - | - | - | - | - | 77,530 | 77,530 | - | - | - | - | - | - | 620,240 | 620,240 |
| Missouri | - | - | - | 48,667 | - | 48,667 | 72,434 | 121,101 | - | - | - | 389,340 | - | 389,340 | 581,676 | 971,016 |
| Montana | 1,734 | 289 | 2,023 | 23,034 | - | 25,057 | 19,341 | 44,398 | 13,872 | 2,312 | 16,184 | 184,279 | - | 200,463 | 154,732 | 355,195 |
| Nevada | 2,621 | - | 2,621 | 26,406 | - | 29,027 | 107,671 | 136,698 | 20,348 | - | 20,348 | 220,974 | - | 241,322 | 861,370 | 1,102,692 |
| New Hampshire | - | - | - | 3,850 | - | 3,850 | (3/) | 3,850 | - | - | - | 30,800 | - | 30,800 | (3/) | 30,800 |
| New Mexico | - | 18 | 18 | 9,640 | - | 9,658 | 14,635 | 24,293 | - | 144 | 144 | 75,874 | - | 76,018 | 117,081 | 193,099 |
| New York | 25,769 | 3,196 | 28,965 | 5,859 | - | 34,824 | 72,278 | 107,102 | 208,151 | 27,168 | 235,319 | 46,869 | - | 282,188 | 578,231 | 860,419 |
| North Carolina | 3,637 | 1,791 | 5,428 | 37,433 | 786 | 43,647 | 82,576 | 126,223 | 29,088 | 14,330 | 43,418 | 301,572 | 6,488 | 351,478 | 661,103 | 1,012,581 |
| Oregon | - | - | - | 6,327 | - | 6,327 | (3/) | 6,327 | - | - | - | 50,528 | - | 50,528 | (3/) | 50,528 |
| Pennsylvania | - | - | - | 2,388 | - | 2,388 | (3/) | 2,388 | - | - | - | 19,102 | - | 19,102 | (3/) | 19,102 |
| South Carolina | - | - | - | 16,271 | - | 16,271 | 31,686 | 47,957 | - | - | - | 147,425 | - | 147,425 | 260,841 | 408,266 |
| South Dakota | 2,510 | 624 | 3,134 | 11,180 | - | 14,314 | (3/) | 14,314 | 20,083 | 4,992 | 25,075 | 88,810 | - | 113,885 | (3/) | 113,885 |
| Tennessee | - | - | - | 9,380 | - | 9,380 | (3/) | 9,380 | - | - | - | 75,978 | - | 75,978 | (3/) | 75,978 |
| Texas | - | - | - | 9,808 | 1,837 | 11,645 | 58,410 | 70,055 | - | - | - | 78,488 | 14,696 | 93,184 | 470,886 | 564,070 |
| Utah | - | - | - | 1,210 | - | 1,210 | 10 | 1,220 | - | - | - | 9,680 | - | 9,680 | 80 | 9,760 |
| Vermont | 9,002 | 1,419 | 10,421 | 16,649 | - | 27,070 | 56,256 | 83,326 | 73,522 | 12,130 | 85,652 | 133,189 | - | 218,841 | 451,805 | 670,646 |
| Virginia | 636 | 225 | 861 | 16,965 | - | 17,826 | 37,597 | 55,423 | 5,088 | 1,798 | 6,886 | 133,510 | - | 140,396 | 290,951 | 431,347 |
| Washington | - | - | - | 7,463 | - | 7,463 | 8,716 | 16,179 | - | - | - | 60,418 | - | 60,418 | 69,729 | 130,147 |
| Wyoming | 49,388 | 10,953 | 60,341 | 446 | 20,998 | 81,785 | 78,678 | 160,463 | 395,897 | 87,624 | 483,521 | 3,573 | 167,986 | 655,080 | 629,427 | 1,284,507 |
| Other States 4/ and/or combined 3/ | 2,496 | 624 | 3,120 | 23,197 | 1,150 | 27,467 | 116,876 | 144,343 | 19,968 | 4,992 | 24,960 | 188,036 | 9,200 | 222,196 | 952,719 | 1,174,915 |
| Total | 231,140 | 41,603 | 272,743 | 423,457 | 107,046 | 803,246 | 2,059,673 | 2,862,919 | 1,857,811 | 336,566 | 2,194,377 | 3,421,720 | 862,476 | 6,478,573 | 16,506,308 | 22,984,881 |

1/ Includes abrasives, aplite, asbestos, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium compounds, talc, soapstone and pyrophyllite, vermiculite, and wollastonite.
2/ Selected data indicated as being concealed in "Other States and/or combined" are not included in the individual State totals.
3/ Combined to avoid disclosure of individual company data.
4/ Includes Alabama with 4 operations, Connecticut with 4, Florida with 2, Nebraska with 2, New Jersey with 4, North Dakota with 1, Ohio with 2, and Oklahoma with 3.

TABLE B-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1964

| State | Injuries: Fatal: Underground mines: Underground | Fatal: Underground mines: Surface | Fatal: Underground mines: Total | Fatal: Open pit mines | Fatal: Other surface mining | Fatal: Total mining activities | Fatal: Mills | Fatal: Grand total | Nonfatal: Underground mines: Underground | Nonfatal: Underground mines: Surface | Nonfatal: Underground mines: Total | Nonfatal: Open pit mines | Nonfatal: Other surface mining | Nonfatal: Total mining activities 1/ | Nonfatal: Mills | Nonfatal: Grand total 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | - | - | - | - | - | - | - | - | 1 | - | 1 | 9 | - | 10 | 26 | 36 |
| Arizona | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 3 | - | 6 | 4 | 10 |
| Arkansas | - | - | - | - | - | - | - | - | 27 | - | 27 | 3 | - | 30 | 48 | 78 |
| California | 2 | - | 2 | - | - | 2 | 1 | 3 | 22 | - | 22 | 20 | 20 | 62 | 111 | 173 |
| Colorado | - | - | - | - | - | - | - | - | 10 | - | 10 | 1 | 1 | 12 | 3 | 15 |
| Connecticut | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 | 3 | 4 |
| Delaware | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 31 | 3 | 34 | 39 | 73 |
| Georgia | - | - | - | 3 | - | 3 | - | 3 | (2/) | - | (2/) | 39 | - | 39 | 179 | 218 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 8 | 4 | 12 | 15 | 27 |
| Illinois | - | - | - | - | - | - | 1 | 1 | 11 | - | 11 | 6 | - | 17 | 83 | 100 |
| Indiana | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - | 1 | 19 | 20 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 10 | - | 10 | 50 | 60 |
| Kansas | - | - | - | - | - | - | - | - | 5 | 1 | 6 | 2 | 1 | 9 | 39 | 48 |
| Kentucky | - | - | - | 1 | - | 1 | - | 1 | 24 | - | 24 | 3 | - | 27 | 10 | 37 |
| Louisiana | - | - | - | - | - | - | - | - | 19 | 12 | 31 | - | 12 | 43 | 78 | 121 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 5 |
| Maryland | - | - | - | - | - | - | - | - | (2/) | - | (2/) | 2 | - | 2 | 20 | 22 |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| Michigan | - | - | - | - | - | - | - | - | 4 | 4 | 8 | - | 2 | 10 | 44 | 54 |
| Minnesota | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | 28 | 28 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 35 | 36 |
| Missouri | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 23 | - | 23 | 32 | 55 |
| Montana | 1 | - | 1 | - | - | 1 | - | 1 | 18 | - | 18 | 4 | - | 22 | 18 | 40 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | 1 | - | 1 | 5 | - | 6 | 34 | 40 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| New Jersey | - | - | - | 1 | - | 1 | - | 1 | - | - | - | 8 | - | 8 | 11 | 19 |
| New Mexico | 4 | - | 4 | - | - | 4 | 1 | 5 | 149 | 19 | 168 | 2 | - | 170 | 53 | 223 |
| New York | - | 1 | 1 | - | - | 1 | - | 1 | 38 | 18 | 56 | 7 | - | 63 | 78 | 141 |
| North Carolina | - | - | - | 1 | - | 1 | - | 1 | 3 | - | 3 | 11 | - | 14 | 66 | 80 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Ohio | - | - | - | - | - | - | - | - | 22 | 3 | 25 | 8 | - | 33 | 80 | 113 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 11 | 14 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 6 | 7 |
| Pennsylvania | - | - | - | - | - | - | 1 | 1 | 12 | 2 | 14 | 17 | - | 31 | 94 | 125 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 7 | - | 7 | 34 | 41 |
| South Dakota | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 2 | - | 5 | 4 | 9 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 22 | - | 22 | 10 | 32 |
| Texas | - | - | - | 1 | - | 1 | - | 1 | 1 | 3 | 4 | 24 | 35 | 63 | 90 | 153 |
| Utah | - | - | - | - | - | - | 1 | 1 | 61 | 3 | 64 | 7 | 2 | 73 | 11 | 84 |
| Vermont | - | - | - | - | - | - | - | - | 6 | 2 | 8 | - | - | 8 | 9 | 17 |
| Virginia | - | - | - | - | - | - | - | - | 1 | - | 1 | 8 | - | 9 | 36 | 45 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| West Virginia | - | - | - | - | - | - | - | - | 5 | - | 5 | 1 | - | 6 | 30 | 36 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Wyoming | - | - | - | - | - | - | - | - | 2 | 1 | 3 | 3 | 1 | 7 | 30 | 37 |
| Combined 2/ | - | - | - | - | - | - | - | - | 3 | - | 3 | - | - | 3 | - | 3 |
| Total | 7 | 1 | 8 | 10 | - | 18 | 6 | 24 | 450 | 70 | 520 | 305 | 81 | 906 | 1,580 | 2,486 |

1/ Selected data indicated as being concealed in "combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.

TABLE B-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1964 - Continued

| State | Frequency rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities 1/ | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | - | - | - | - | - | - | - | - | 27.46 | - | 18.82 | 45.67 | - | 37.35 | 12.07 | 14.86 |
| Arizona | - | - | - | - | - | - | - | - | 16.96 | 37.55 | 20.75 | 15.01 | - | 17.42 | 12.08 | 14.80 |
| Arkansas | - | - | - | - | - | - | - | - | 275.74 | - | 222.91 | 16.18 | - | 97.88 | 51.41 | 62.90 |
| California | 5.78 | - | 4.96 | - | - | 0.83 | 0.12 | 0.28 | 63.62 | - | 54.53 | 16.34 | 25.34 | 25.65 | 13.68 | 16.43 |
| Colorado | - | - | - | - | - | - | - | - | 93.40 | - | 74.75 | 6.06 | .69 | 39.97 | 14.62 | 29.68 |
| Connecticut | - | - | - | - | - | - | - | - | 50.08 | - | 40.06 | - | - | 14.00 | 18.41 | 17.07 |
| Delaware | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | 0.33 | - | .32 | - | .13 | - | - | - | 10.27 | 50.74 | 11.04 | 8.04 | 9.20 |
| Georgia | - | - | - | 1.81 | - | 1.81 | - | .34 | (2/) | - | (2/) | 23.51 | - | 23.51 | 25.02 | 24.74 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 56.89 | 13.18 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 17.55 | 416.67 | 25.78 | 29.47 | 27.71 |
| Illinois | - | - | - | - | - | - | .52 | .38 | 25.53 | - | 22.09 | 36.65 | - | 25.69 | 42.87 | 38.49 |
| Indiana | - | - | - | - | - | - | .70 | .62 | - | - | - | 11.27 | - | 5.65 | 13.25 | 12.41 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 32.21 | - | 27.73 | 46.61 | 41.86 |
| Kansas | - | - | - | - | - | - | - | - | 37.52 | 25.53 | 34.80 | 29.99 | 15.74 | 29.74 | 18.16 | 19.59 |
| Kentucky | - | - | - | 8.06 | - | 2.31 | - | 1.34 | 95.92 | - | 82.49 | 24.18 | - | 62.32 | 31.67 | 49.40 |
| Louisiana | - | - | - | - | - | - | - | - | 52.47 | 39.86 | 46.75 | - | 6.94 | 17.35 | 33.13 | 25.04 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 55.91 | 25.89 |
| Maryland | - | - | - | - | - | - | - | - | (2/) | - | (2/) | 29.54 | - | 29.54 | 44.27 | 42.35 |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | - | 48.45 | - | 48.45 | - | 48.45 |
| Michigan | - | - | - | - | - | - | - | - | 14.71 | 35.37 | 20.78 | - | 10.73 | 13.33 | 9.26 | 9.82 |
| Minnesota | - | - | - | 23.94 | - | 23.94 | - | 2.03 | - | - | - | - | - | - | 62.03 | 56.77 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 3.21 | - | 3.21 | 20.91 | 18.13 |
| Missouri | - | - | - | 1.26 | - | 1.26 | - | .54 | - | - | - | 29.01 | - | 28.87 | 30.36 | 29.72 |
| Montana | 1.13 | - | .92 | - | - | .78 | - | .52 | 20.26 | - | 16.49 | 20.86 | - | 17.15 | 28.31 | 20.85 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | 41.62 | - | 40.28 | 13.99 | - | 15.69 | 23.05 | 21.54 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 23.50 | - | 23.50 | - | 18.17 |
| New Jersey | - | - | - | 4.77 | - | 4.57 | - | 1.18 | - | - | - | 38.15 | - | 36.55 | 17.44 | 22.39 |
| New Mexico | 1.22 | - | .77 | - | - | .75 | .35 | .61 | 45.60 | 9.90 | 32.39 | 18.10 | - | 31.99 | 18.71 | 27.37 |
| New York | - | 2.76 | .65 | - | - | .53 | - | .19 | 32.04 | 49.63 | 36.16 | 25.74 | - | 33.64 | 23.33 | 27.03 |
| North Carolina | - | - | - | 1.77 | - | 1.63 | - | .33 | 103.14 | - | 69.10 | 19.50 | - | 22.80 | 27.10 | 26.23 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 14.63 | 12.69 |
| Ohio | - | - | - | - | - | - | - | - | 34.52 | 23.84 | 32.76 | 11.15 | - | 21.65 | 21.09 | 21.25 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 8.99 | - | 8.86 | 36.16 | 21.78 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 12.15 | - | 12.15 | 43.39 | 31.73 |
| Pennsylvania | - | - | - | - | - | - | .44 | .29 | 53.16 | 34.25 | 49.27 | 17.80 | - | 25.02 | 41.51 | 35.68 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 16.85 | - | 16.85 | 20.58 | 19.83 |
| South Dakota | - | - | - | - | - | - | - | - | 99.59 | 200.32 | 119.64 | 14.38 | - | 30.45 | 13.05 | 19.12 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 25.79 | - | 25.79 | 11.23 | 18.36 |
| Texas | - | - | - | 1.29 | - | .29 | - | .16 | 14.56 | 22.65 | 19.89 | 31.03 | 14.38 | 18.49 | 30.33 | 24.00 |
| Utah | - | - | - | - | - | - | 2.07 | .81 | 143.72 | 29.74 | 121.83 | 43.87 | 29.54 | 97.00 | 22.74 | 67.94 |
| Vermont | - | - | - | - | - | - | - | - | 81.61 | 164.88 | 93.40 | - | - | 36.01 | 19.92 | 25.22 |
| Virginia | - | - | - | - | - | - | - | - | 4.59 | - | 4.13 | 32.37 | - | 18.39 | 37.32 | 30.95 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 13.05 | - | 13.05 | - | 6.67 |
| West Virginia | - | - | - | - | - | - | - | - | 46.09 | - | 41.43 | 49.43 | - | 33.36 | 14.37 | 15.87 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 19.22 | 18.70 |
| Wyoming | - | - | - | - | - | - | - | - | 5.05 | 11.41 | 6.20 | 9.96 | 5.93 | 7.34 | 23.99 | 16.79 |
| Combined 2/ | - | - | - | - | - | - | - | - | 87.37 | - | 68.93 | - | - | 68.93 | - | 17.16 |
| Total or average | .71 | .26 | .58 | .60 | - | .50 | .08 | .22 | 45.49 | 18.39 | 37.96 | 18.43 | 14.13 | 25.18 | 22.11 | 23.14 |

1/ Selected data indicated as being concealed in "combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.

TABLE B-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1964 - Continued

| State | Severity rates per million man-hours | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | | | | | | | | Nonfatal | | | | | | | |
| | Underground mines | | | Open pit mines | Other surface mining | Total mining activities | Mills | Grand total | Underground mines | | | Open pit mines | Other surface mining | Total mining activities 1/ | Mills | Grand total 1/ |
| | Underground | Surface | Total | | | | | | Underground | Surface | Total | | | | | |
| Alabama | - | - | - | - | - | - | - | - | 55 | - | 38 | 1,573 | - | 1,165 | 184 | 293 |
| Arizona | - | - | - | - | - | - | - | - | 1,196 | 751 | 1,114 | 710 | - | 880 | 178 | 536 |
| Arkansas | - | - | - | - | - | - | - | - | 2,390 | - | 1,932 | 146 | - | 852 | 2,305 | 1,946 |
| California | 34,701 | - | 24,744 | - | - | 4,965 | 740 | 1,710 | 1,255 | - | 1,076 | 465 | 1,056 | 760 | 383 | 469 |
| Colorado | - | - | - | - | - | - | - | - | 3,596 | - | 2,878 | 618 | 59,444 | 1,955 | 1,413 | 1,735 |
| Delaware | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Florida | - | - | - | 1,987 | - | 1,949 | - | 757 | - | - | - | 3,317 | 1,184 | 3,276 | 203 | 1,396 |
| Georgia | - | - | - | 10,852 | - | 10,852 | - | 2,043 | (2/) | - | (2/) | 1,431 | - | 1,431 | 628 | 779 |
| Hawaii | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 512 | 119 |
| Idaho | - | - | - | - | - | - | - | - | - | - | - | 327 | 11,667 | 561 | 1,090 | 837 |
| Illinois | - | - | - | - | - | - | 3,099 | 2,310 | 866 | - | 749 | 458 | - | 677 | 1,896 | 1,585 |
| Indiana | - | - | - | - | - | - | 4,183 | 3,724 | - | - | - | 271 | - | 136 | 457 | 422 |
| Iowa | - | - | - | - | - | - | - | - | - | - | - | 351 | - | 302 | 6,357 | 4,833 |
| Kansas | - | - | - | - | - | - | - | - | 120 | 843 | 284 | 2,159 | 47,229 | 10,551 | 1,631 | 2,733 |
| Kentucky | - | - | - | 48,363 | - | 13,849 | - | 8,011 | 1,463 | - | 1,258 | 56 | - | 861 | 690 | 789 |
| Louisiana | - | - | - | - | - | - | - | - | 8,464 | 1,505 | 5,305 | - | 264 | 1,604 | 741 | 1,183 |
| Maine | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 559 | 259 |
| Maryland | - | - | - | - | - | - | - | - | (2/) | - | (2/) | 1,078 | - | 1,078 | 828 | 860 |
| Massachusetts | - | - | - | - | - | - | - | - | - | - | - | 1,163 | - | 1,163 | - | 1,163 |
| Michigan | - | - | - | - | - | - | - | - | 40 | 2,609 | 795 | - | 268 | 474 | 456 | 459 |
| Minnesota | - | - | - | 143,633 | - | 143,633 | - | 12,166 | - | - | - | - | - | - | 1,012 | 927 |
| Mississippi | - | - | - | - | - | - | - | - | - | - | - | 48 | - | 48 | 1,445 | 1,225 |
| Missouri | - | - | - | 7,567 | - | 7,531 | - | 3,242 | - | - | - | 840 | - | 836 | 663 | 738 |
| Montana | 6,754 | - | 5,498 | - | - | 4,676 | - | 3,127 | 769 | - | 626 | 151 | - | 555 | 7,611 | 2,893 |
| Nebraska | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Nevada | - | - | - | - | - | - | - | - | 4,079 | - | 3,947 | 229 | - | 471 | 1,616 | 1,380 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | 1,645 | - | 1,645 | - | 1,272 |
| New Jersey | - | - | - | 28,611 | - | 27,409 | - | 7,070 | - | - | - | 753 | - | 722 | 889 | 846 |
| New Mexico | 7,345 | - | 4,627 | - | - | 4,516 | 2,118 | 3,682 | 1,744 | 1,656 | 1,711 | 1,783 | - | 1,707 | 390 | 1,249 |
| New York | - | 16,543 | 3,874 | - | - | 3,203 | - | 1,150 | 1,888 | 3,424 | 2,248 | 798 | - | 1,974 | 448 | 996 |
| North Carolina | - | - | - | 10,635 | - | 9,770 | - | 1,967 | 6,704 | - | 4,491 | 606 | - | 874 | 2,614 | 2,264 |
| North Dakota | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1,405 | 1,218 |
| Ohio | - | - | - | - | - | - | - | - | 910 | 32 | 765 | 279 | - | 514 | 825 | 736 |
| Oklahoma | - | - | - | - | - | - | - | - | - | - | - | 198 | - | 195 | 316 | 252 |
| Oregon | - | - | - | - | - | - | - | - | - | - | - | 753 | - | 753 | 745 | 748 |
| Pennsylvania | - | - | - | - | - | - | 2,649 | 1,712 | 15,603 | 959 | 12,628 | 276 | - | 3,109 | 877 | 1,666 |
| South Carolina | - | - | - | - | - | - | - | - | - | - | - | 604 | - | 604 | 774 | 740 |
| South Dakota | - | - | - | - | - | - | - | - | 13,793 | 1,002 | 11,246 | 151 | - | 1,845 | 385 | 894 |
| Tennessee | - | - | - | - | - | - | - | - | - | - | - | 788 | - | 788 | 434 | 607 |
| Texas | - | - | - | 7,758 | - | 1,761 | - | 941 | 44 | 272 | 194 | 663 | 379 | 433 | 4,633 | 2,388 |
| Utah | - | - | - | - | - | - | 12,402 | 4,853 | 2,236 | 704 | 1,942 | 2,256 | 2,112 | 2,024 | 271 | 1,338 |
| Vermont | - | - | - | - | - | - | - | - | 558 | 742 | 584 | - | - | 225 | 232 | 230 |
| Virginia | - | - | - | - | - | - | - | - | 271 | - | 244 | 1,570 | - | 913 | 1,160 | 1,077 |
| Washington | - | - | - | - | - | - | - | - | - | - | - | 13 | - | 13 | - | 7 |
| West Virginia | - | - | - | - | - | - | - | - | 793 | - | 713 | 692 | - | 556 | 178 | 208 |
| Wisconsin | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 106 | 103 |
| Wyoming | - | - | - | - | - | - | - | - | 649 | 856 | 687 | 734 | 6 | 581 | 386 | 470 |
| Combined 2/ | - | - | - | - | - | - | - | - | 1,194 | - | 942 | 1,107 | - | 942 | - | 235 |
| Total or average | 4,245 | 1,576 | 3,504 | 3,626 | - | 3,002 | 504 | 1,340 | 2,000 | 1,439 | 1,844 | 1,145 | 992 | 1,387 | 1,046 | 1,160 |

1/ Selected data indicated as being concealed in "combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.

TABLE B-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, by State, 1964 - Continued

| State | Active operations: Underground mines | Active operations: Surface mines | Active operations: Mills | Men employed: Underground mines: Underground | Men employed: Underground mines: Surface | Men employed: Underground mines: Total | Men employed: Open pit mines | Men employed: Other surface mining | Men employed: Total mining activities 1/ | Men employed: Mills | Men employed: Grand total 1/ | Average days active: Underground mines | Average days active: Open pit mines | Average days active: Other surface mining | Average days active: Total mining activities 1/ | Average days active: Mills |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 3 | 36 | 21 | 22 | 12 | 34 | 103 | 6 | 143 | 921 | 1,064 | 205 | 238 | 365 | 236 | 290 |
| Arizona | 4 | 33 | 12 | 76 | 17 | 93 | 128 | - | 221 | 157 | 378 | 194 | 196 | - | 195 | 264 |
| Arkansas | 2 | 36 | 16 | 59 | 14 | 73 | 116 | - | 189 | 453 | 642 | 207 | 200 | - | 203 | 258 |
| California | 27 | 220 | 96 | 172 | 30 | 202 | 753 | 338 | 1,293 | 3,541 | 4,834 | 250 | 201 | 289 | 232 | 289 |
| Colorado | 12 | 77 | 20 | 53 | 13 | 66 | 181 | 6 | 253 | 157 | 410 | 253 | 116 | 30 | 150 | 165 |
| Connecticut | 1 | 7 | 3 | 8 | 2 | 10 | 24 | - | 34 | 76 | 110 | 312 | 238 | - | 260 | 295 |
| Delaware | - | 1 | - | - | - | - | 1 | - | 1 | - | 1 | - | 208 | - | 208 | 208 |
| Florida | - | 43 | 32 | - | - | - | 1,162 | 27 | 1,189 | 1,920 | 3,109 | - | 323 | 274 | 322 | 316 |
| Georgia | 2 | 55 | 43 | (2/) | (2/) | (2/) | 775 | - | 775 | 2,794 | 3,569 | (2/) | 266 | - | 266 | 319 |
| Hawaii | - | 25 | 3 | - | - | - | 72 | 1 | 73 | 17 | 90 | - | 97 | 312 | 100 | 129 |
| Idaho | - | 19 | 10 | - | - | - | 239 | 8 | 247 | 208 | 455 | - | 234 | 150 | 231 | 306 |
| Illinois | 21 | 38 | 29 | 227 | 37 | 264 | 100 | - | 364 | 1,018 | 1,382 | 236 | 199 | - | 226 | 238 |
| Indiana | 3 | 36 | 18 | 36 | 9 | 45 | 72 | - | 117 | 701 | 818 | 245 | 154 | - | 189 | 257 |
| Iowa | 1 | 30 | 25 | 23 | 2 | 25 | 145 | - | 170 | 554 | 724 | 251 | 267 | - | 265 | 239 |
| Kansas | 5 | 29 | 19 | 61 | 18 | 79 | 52 | 24 | 155 | 932 | 1,087 | 271 | 158 | 331 | 242 | 288 |
| Kentucky | 4 | 41 | 16 | 115 | 21 | 136 | 113 | 9 | 258 | 172 | 430 | 267 | 136 | 253 | 209 | 229 |
| Louisiana | 7 | 28 | 16 | 162 | 139 | 301 | 45 | 492 | 838 | 1,104 | 1,942 | 267 | 222 | 362 | 324 | 266 |
| Maine | 3 | 14 | 4 | 2 | - | 2 | 64 | - | 66 | 66 | 132 | 25 | 201 | - | 196 | 170 |
| Maryland | 1 | 18 | 10 | (2/) | (2/) | (2/) | 39 | - | 39 | 216 | 255 | (2/) | 210 | - | 210 | 256 |
| Massachusetts | - | 4 | 1 | - | - | - | 11 | - | 11 | (2/) | 11 | (2/) | - | - | (2/) | (2/) |
| Michigan | 3 | 44 | 23 | 130 | 56 | 186 | 88 | 83 | 357 | 1,946 | 2,303 | 259 | 248 | 282 | 262 | 306 |
| Minnesota | - | 10 | 6 | - | - | - | 27 | - | 27 | 222 | 249 | - | 193 | - | 193 | 254 |
| Mississippi | - | 35 | 22 | - | - | - | 176 | - | 176 | 796 | 972 | - | 220 | - | 220 | 263 |
| Missouri | - | 136 | 25 | - | - | - | 506 | 3 | 509 | 476 | 985 | - | 195 | 160 | 195 | 276 |
| Montana | 13 | 17 | 13 | 400 | 94 | 494 | 108 | - | 602 | 261 | 863 | 279 | 222 | - | 269 | 304 |
| Nebraska | - | 6 | 3 | - | - | - | 10 | - | 10 | (2/) | 10 | - | 222 | - | 222 | (2/) |
| Nevada | 11 | 43 | 21 | 26 | 1 | 27 | 195 | 1 | 223 | 650 | 873 | 118 | 223 | 23 | 209 | 284 |
| New Hampshire | - | 8 | 1 | - | - | - | 40 | - | 40 | 6 | 46 | - | 133 | - | 133 | 260 |
| New Jersey | - | 20 | 11 | - | - | - | 109 | 5 | 114 | 260 | 374 | - | 240 | 230 | 240 | 303 |
| New Mexico | 12 | 41 | 27 | 1,208 | 700 | 1,908 | 76 | 10 | 1,994 | 1,093 | 3,087 | 340 | 184 | 209 | 333 | 324 |
| New York | 12 | 32 | 32 | 501 | 150 | 651 | 187 | 25 | 863 | 1,601 | 2,464 | 275 | 182 | 261 | 255 | 260 |
| North Carolina | 4 | 91 | 40 | 20 | 8 | 28 | 330 | 3 | 361 | 1,316 | 1,677 | 194 | 212 | 262 | 211 | 238 |
| North Dakota | - | 6 | 3 | - | - | - | 9 | 3 | 12 | 26 | 38 | - | 22 | 365 | 108 | 329 |
| Ohio | 18 | 141 | 52 | 306 | 59 | 365 | 419 | 19 | 803 | 1,820 | 2,623 | 261 | 214 | 289 | 238 | 260 |
| Oklahoma | - | 32 | 9 | - | - | - | 183 | 3 | 186 | 167 | 353 | - | 229 | 203 | 229 | 226 |
| Oregon | - | 24 | 8 | - | - | - | 59 | - | 59 | 78 | 137 | - | 174 | - | 174 | 222 |
| Pennsylvania | 20 | 108 | 41 | 142 | 37 | 179 | 495 | - | 674 | 1,106 | 1,780 | 203 | 232 | - | 224 | 256 |
| South Carolina | - | 46 | 24 | - | - | - | 203 | - | 203 | 745 | 948 | - | 238 | - | 238 | 269 |
| South Dakota | 3 | 24 | 5 | 9 | 2 | 11 | 92 | - | 103 | 122 | 225 | 285 | 184 | - | 195 | 309 |
| Tennessee | - | 56 | 18 | - | - | - | 424 | - | 424 | 397 | 821 | - | 244 | - | 244 | 277 |
| Texas | 3 | 128 | 59 | 35 | 65 | 100 | 409 | 843 | 1,352 | 1,319 | 2,671 | 253 | 231 | 362 | 314 | 266 |
| Utah | 5 | 40 | 17 | 229 | 44 | 273 | 125 | 34 | 432 | 229 | 661 | 240 | 160 | 249 | 218 | 264 |
| Vermont | 3 | 2 | 5 | 30 | 5 | 35 | 69 | - | 104 | 199 | 303 | 298 | 247 | - | 264 | 283 |
| Virginia | 3 | 25 | 16 | 104 | 11 | 115 | 138 | - | 253 | 448 | 701 | 263 | 223 | - | 241 | 272 |
| Washington | - | 33 | 6 | - | - | - | 91 | - | 91 | 56 | 147 | - | 104 | - | 104 | 163 |
| West Virginia | 4 | 10 | 10 | 59 | 8 | 67 | 12 | 15 | 94 | 863 | 957 | 225 | 224 | 330 | 242 | 303 |
| Wisconsin | - | 5 | 3 | - | - | - | 10 | - | 10 | 94 | 104 | - | 42 | - | 42 | 132 |
| Wyoming | 3 | 24 | 17 | 199 | 44 | 243 | 154 | 154 | 551 | 601 | 1,152 | 248 | 231 | 137 | 212 | 260 |
| Combined 2/ | - | - | - | 19 | 5 | 24 | - | - | 24 | 63 | 87 | 192 | 232 | - | 192 | 261 |
| Total or average | 213 | 1,977 | 911 | 4,433 | 1,603 | 6,036 | 8,939 | 2,112 | 17,087 | 31,967 | 49,054 | 282 | 228 | 321 | 259 | 279 |

1/ Selected data indicated as being concealed in "combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.

TABLE B-21. - Injury experience and employment data by general work location at nonmetal mines and mills in the United States, 1964 - Continued

| State | Man-days worked: Underground mines: Underground | Man-days worked: Underground mines: Surface | Man-days worked: Underground mines: Total | Man-days worked: Open pit mines | Man-days worked: Other surface mining | Man-days worked: Total mining activities 1/ | Man-days worked: Mills | Man-days worked: Grand total 1/ | Man-hours worked: Underground mines: Underground | Man-hours worked: Underground mines: Surface | Man-hours worked: Underground mines: Total | Man-hours worked: Open pit mines | Man-hours worked: Other surface mining | Man-hours worked: Total mining activities 1/ | Man-hours worked: Mills | Man-hours worked: Grand total 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 4,709 | 2,246 | 6,955 | 24,562 | 2,190 | 33,707 | 266,703 | 300,410 | 36,422 | 16,724 | 53,146 | 197,068 | 17,520 | 267,734 | 2,154,428 | 2,422,162 |
| Arizona | 14,741 | 3,329 | 18,070 | 25,060 | - | 43,130 | 41,392 | 84,522 | 117,928 | 26,632 | 144,560 | 199,860 | - | 344,420 | 331,102 | 675,522 |
| Arkansas | 12,240 | 2,901 | 15,141 | 23,158 | - | 38,299 | 116,706 | 155,005 | 97,920 | 23,207 | 121,127 | 185,381 | - | 306,508 | 933,627 | 1,240,135 |
| California | 43,258 | 7,214 | 50,472 | 151,682 | 97,535 | 299,689 | 1,022,890 | 1,322,579 | 345,809 | 57,636 | 403,445 | 1,224,149 | 789,124 | 2,416,718 | 8,112,150 | 10,528,868 |
| Colorado | 13,357 | 3,341 | 16,698 | 21,002 | 180 | 37,880 | 25,841 | 63,721 | 107,066 | 26,722 | 133,788 | 165,026 | 1,440 | 300,254 | 205,173 | 505,427 |
| Connecticut | 2,496 | 624 | 3,120 | 5,703 | - | 8,823 | 22,400 | 31,223 | 19,968 | 4,992 | 24,960 | 46,486 | - | 71,446 | 162,944 | 234,390 |
| Delaware | - | - | - | 208 | - | 208 | - | 208 | - | - | - | 1,040 | - | 1,040 | - | 1,040 |
| Florida | - | - | - | 374,160 | 7,390 | 382,550 | 605,815 | 988,365 | - | - | - | 3,019,200 | 59,120 | 3,078,320 | 4,852,775 | 7,931,095 |
| Georgia | (2/) | (2/) | (2/) | 206,250 | - | 206,250 | 891,820 | 1,098,070 | (2/) | (2/) | (2/) | 1,658,668 | - | 1,658,668 | 7,153,578 | 8,812,246 |
| Hawaii | - | - | - | 6,967 | 312 | 7,279 | 2,197 | 9,476 | - | - | - | 57,026 | 1,248 | 58,274 | 17,578 | 75,852 |
| Idaho | - | - | - | 55,813 | 1,200 | 57,013 | 63,619 | 120,632 | - | - | - | 455,855 | 9,600 | 465,455 | 508,964 | 974,419 |
| Illinois | 53,860 | 8,390 | 62,250 | 19,928 | - | 82,178 | 241,838 | 324,016 | 430,874 | 67,122 | 497,996 | 163,707 | - | 661,703 | 1,936,221 | 2,597,924 |
| Indiana | 8,802 | 2,244 | 11,046 | 11,059 | - | 22,105 | 179,818 | 201,923 | 70,265 | 17,952 | 88,217 | 88,695 | - | 176,912 | 1,434,317 | 1,611,229 |
| Iowa | 5,852 | 418 | 6,270 | 38,785 | - | 45,055 | 132,681 | 177,736 | 46,816 | 3,345 | 50,161 | 310,487 | - | 360,648 | 1,072,735 | 1,433,383 |
| Kansas | 16,377 | 5,015 | 21,392 | 8,235 | 7,940 | 37,567 | 268,858 | 306,425 | 133,257 | 39,163 | 172,420 | 66,698 | 63,520 | 302,638 | 2,148,030 | 2,450,668 |
| Kentucky | 31,276 | 5,092 | 36,368 | 15,357 | 2,281 | 54,006 | 39,379 | 93,385 | 250,203 | 40,738 | 290,941 | 124,062 | 18,244 | 433,247 | 315,762 | 749,009 |
| Louisiana | 45,260 | 37,897 | 83,157 | 9,975 | 177,980 | 271,112 | 293,351 | 564,463 | 362,127 | 301,039 | 663,166 | 85,175 | 1,729,870 | 2,478,211 | 2,354,713 | 4,832,924 |
| Maine | 50 | - | 50 | 12,856 | - | 12,906 | 11,209 | 24,115 | 400 | - | 400 | 103,312 | - | 103,712 | 89,432 | 193,144 |
| Maryland | (2/) | (2/) | (2/) | 8,179 | - | 8,179 | 55,399 | 63,578 | (2/) | (2/) | (2/) | 67,700 | - | 67,700 | 451,821 | 519,521 |
| Massachusetts | - | - | - | 2,580 | - | 2,580 | (2/) | 2,580 | - | - | - | 20,641 | - | 20,641 | (2/) | 20,641 |
| Michigan | 33,997 | 14,135 | 48,132 | 21,806 | 23,442 | 93,380 | 594,529 | 687,909 | 271,977 | 113,082 | 385,059 | 179,028 | 186,330 | 750,417 | 4,749,536 | 5,499,953 |
| Minnesota | - | - | - | 5,222 | - | 5,222 | 56,425 | 61,647 | - | - | - | 41,773 | - | 41,773 | 451,405 | 493,178 |
| Mississippi | - | - | - | 38,730 | - | 38,730 | 208,996 | 247,726 | - | - | - | 312,005 | - | 312,005 | 1,673,611 | 1,985,616 |
| Missouri | - | - | - | 98,648 | 481 | 99,129 | 131,459 | 230,588 | - | - | - | 792,880 | 3,848 | 796,728 | 1,053,883 | 1,850,611 |
| Montana | 112,389 | 25,296 | 137,685 | 23,968 | - | 161,653 | 79,466 | 241,119 | 888,314 | 203,069 | 1,091,383 | 191,748 | - | 1,283,131 | 635,761 | 1,918,892 |
| Nebraska | - | - | - | 2,216 | - | 2,216 | (2/) | 2,216 | - | - | - | 17,429 | - | 17,429 | (2/) | 17,429 |
| Nevada | 3,081 | 100 | 3,181 | 43,399 | 23 | 46,603 | 184,491 | 231,094 | 24,028 | 800 | 24,828 | 357,416 | 184 | 382,428 | 1,474,913 | 1,857,341 |
| New Hampshire | - | - | - | 5,319 | - | 5,319 | 1,560 | 6,879 | - | - | - | 42,552 | - | 42,552 | 12,480 | 55,032 |
| New Jersey | - | - | - | 26,183 | 1,150 | 27,333 | 78,718 | 106,051 | - | - | - | 209,706 | 9,200 | 218,906 | 629,740 | 848,646 |
| New Mexico | 408,466 | 239,941 | 648,407 | 13,971 | 2,089 | 664,467 | 354,128 | 1,018,595 | 3,267,733 | 1,919,534 | 5,187,267 | 110,517 | 16,715 | 5,314,499 | 2,833,019 | 8,147,518 |
| New York | 137,357 | 41,868 | 179,225 | 34,057 | 6,531 | 219,813 | 416,452 | 636,265 | 1,186,126 | 362,688 | 1,548,814 | 271,977 | 52,247 | 1,873,038 | 3,343,800 | 5,216,838 |
| North Carolina | 3,637 | 1,791 | 5,428 | 69,994 | 786 | 76,208 | 312,555 | 388,763 | 29,088 | 14,330 | 43,418 | 564,190 | 6,488 | 614,096 | 2,435,529 | 3,049,625 |
| North Dakota | - | - | - | 202 | 1,095 | 1,297 | 8,543 | 9,840 | - | - | - | 1,704 | 8,760 | 10,464 | 68,346 | 78,810 |
| Ohio | 79,696 | 15,729 | 95,425 | 89,827 | 5,493 | 190,745 | 473,209 | 663,954 | 637,280 | 125,824 | 763,104 | 717,176 | 43,920 | 1,524,200 | 3,792,927 | 5,317,127 |
| Oklahoma | - | - | - | 41,929 | 610 | 42,539 | 37,800 | 80,339 | - | - | - | 333,562 | 4,880 | 338,442 | 304,231 | 642,673 |
| Oregon | - | - | - | 10,242 | - | 10,242 | 17,286 | 27,528 | - | - | - | 82,314 | - | 82,314 | 138,268 | 220,582 |
| Pennsylvania | 28,504 | 7,829 | 36,333 | 114,684 | - | 151,017 | 282,878 | 433,895 | 225,733 | 58,395 | 284,128 | 954,936 | - | 1,239,064 | 2,264,755 | 3,503,819 |
| South Carolina | - | - | - | 48,322 | - | 48,322 | 200,323 | 248,645 | - | - | - | 415,309 | - | 415,309 | 1,651,746 | 2,067,055 |
| South Dakota | 2,510 | 624 | 3,134 | 16,920 | - | 20,054 | 37,670 | 57,724 | 20,083 | 4,992 | 25,075 | 139,130 | - | 164,205 | 306,567 | 470,772 |
| Tennessee | - | - | - | 103,276 | - | 103,276 | 109,935 | 213,211 | - | - | - | 853,049 | - | 853,049 | 890,229 | 1,743,278 |
| Texas | 8,465 | 16,828 | 25,293 | 94,590 | 305,195 | 425,078 | 351,353 | 776,431 | 68,670 | 132,432 | 201,102 | 773,383 | 2,433,606 | 3,408,091 | 2,967,763 | 6,375,854 |
| Utah | 53,055 | 12,595 | 65,650 | 20,022 | 8,464 | 94,136 | 60,513 | 154,649 | 424,444 | 100,863 | 525,307 | 159,570 | 67,716 | 752,593 | 483,793 | 1,236,386 |
| Vermont | 9,002 | 1,419 | 10,421 | 17,066 | - | 27,487 | 56,256 | 83,743 | 73,522 | 12,130 | 85,652 | 136,523 | - | 222,175 | 451,805 | 673,980 |
| Virginia | 27,258 | 3,027 | 30,285 | 30,733 | - | 61,018 | 121,984 | 183,002 | 218,066 | 24,214 | 242,280 | 247,106 | - | 489,386 | 964,551 | 1,453,937 |
| Washington | - | - | - | 9,439 | - | 9,439 | 9,140 | 18,579 | - | - | - | 76,639 | - | 76,639 | 73,222 | 149,861 |
| West Virginia | 13,565 | 1,527 | 15,092 | 2,682 | 4,945 | 22,719 | 261,172 | 283,891 | 108,480 | 12,200 | 120,680 | 20,232 | 38,918 | 179,830 | 2,088,261 | 2,268,091 |
| Wisconsin | - | - | - | 418 | - | 418 | 12,445 | 12,863 | - | - | - | 2,908 | - | 2,908 | 104,054 | 106,962 |
| Wyoming | 49,388 | 10,953 | 60,341 | 35,608 | 21,058 | 117,007 | 156,127 | 273,134 | 395,897 | 87,624 | 483,521 | 301,198 | 168,586 | 953,305 | 1,250,322 | 2,203,627 |
| Combined 2/ | 3,632 | 968 | 4,600 | - | - | 4,600 | 16,445 | 21,045 | 34,336 | 9,184 | 43,520 | - | - | 43,520 | 131,257 | 174,777 |
| Total | 1,226,280 | 473,341 | 1,699,621 | 2,041,992 | 678,370 | 4,419,983 | 8,913,774 | 13,333,757 | 9,892,832 | 3,806,633 | 13,699,465 | 16,546,196 | 5,731,084 | 35,976,745 | 71,461,124 | 107,437,869 |

1/ Selected data indicated as being concealed in "combined" are not included in the individual State totals.
2/ Combined to avoid disclosure of individual company data.

TABLE B-22. - Injury experience and employment data on officeworkers at nonmetal mines and mills in the United States, by mineral industry, 1964

| Mineral industry | Injuries | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | | | | |
| Clay | - | 3 | 3 | - | 1.16 | 1.16 | - | 83 | 83 | 1,252 | 256 | 320,381 | 2,591,012 |
| Gypsum | - | - | - | - | - | - | - | - | - | 423 | 246 | 104,135 | 831,665 |
| Phosphate rock | - | - | - | - | - | - | - | - | - | 369 | 260 | 95,906 | 766,491 |
| Potash | - | - | - | - | - | - | - | - | - | 170 | 301 | 51,254 | 410,241 |
| Salt | - | - | - | - | - | - | - | - | - | 947 | 264 | 249,791 | 1,988,243 |
| Sulfur | - | - | - | - | - | - | - | - | - | 9 | 255 | 2,299 | 18,395 |
| Miscellaneous nonmetals 1/ | - | 1 | 1 | - | .46 | .46 | - | 11 | 11 | 1,193 | 231 | 275,486 | 2,194,827 |
| Total or average | - | 4 | 4 | - | .45 | .45 | - | 27 | 27 | 4,363 | 252 | 1,099,252 | 8,800,874 |

1/ Includes abrasives, asbestos, aplite, barite, boron minerals, bromine, calcium chloride, diatomite, feldspar, fluorspar, graphite, greensand, iodine, kyanite, lithium, magnesite, mica, mineral pigments, perlite, pumice, sodium, talc, soapstone and pyrophyllite, vermiculite and wollastonite.

TABLE B-23. - Injury experience and employment data on officeworkers at nonmetal mines and mills in the United States, by State, 1964

| State | Injuries | | | Frequency rates per million man-hours | | | Severity rates per million man-hours | | | Men employed | Average days active | Man-days worked | Man-hours worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | Fatal | Nonfatal | Total | | | | |
| Alabama | - | - | - | - | - | - | - | - | - | 37 | 298 | 11,035 | 88,947 |
| Arizona | - | - | - | - | - | - | - | - | - | 21 | 264 | 5,545 | 44,362 |
| Arkansas | - | - | - | - | - | - | - | - | - | 61 | 237 | 14,460 | 115,244 |
| California | - | - | - | - | - | - | - | - | - | 652 | 255 | 166,480 | 1,329,331 |
| Colorado | - | - | - | - | - | - | - | - | - | 13 | 197 | 2,567 | 19,854 |
| Connecticut | - | - | - | - | - | - | - | - | - | 7 | 262 | 1,834 | 14,668 |
| District of Columbia | - | - | - | - | - | - | - | - | - | 2 | 260 | 520 | 4,160 |
| Florida | - | - | - | - | - | - | - | - | - | 284 | 279 | 79,208 | 633,525 |
| Georgia | - | - | - | - | - | - | - | - | - | 358 | 255 | 91,319 | 749,981 |
| Hawaii | - | - | - | - | - | - | - | - | - | 4 | 211 | 844 | 6,750 |
| Idaho | - | - | - | - | - | - | - | - | - | 79 | 199 | 15,732 | 125,855 |
| Illinois | - | - | - | - | - | - | - | - | - | 99 | 270 | 26,735 | 219,711 |
| Indiana | - | - | - | - | - | - | - | - | - | 80 | 260 | 20,769 | 166,246 |
| Iowa | - | - | - | - | - | - | - | - | - | 63 | 263 | 16,580 | 132,728 |
| Kansas | - | - | - | - | - | - | - | - | - | 127 | 245 | 31,128 | 245,028 |
| Kentucky | - | - | - | - | - | - | - | - | - | 25 | 263 | 6,580 | 50,930 |
| Louisiana | - | - | - | - | - | - | - | - | - | 134 | 264 | 35,428 | 283,721 |
| Maine | - | - | - | - | - | - | - | - | - | 4 | 272 | 1,087 | 8,696 |
| Maryland | - | - | - | - | - | - | - | - | - | 12 | 246 | 2,947 | 23,319 |
| Massachusetts | - | - | - | - | - | - | - | - | - | 5 | 255 | 1,275 | 10,200 |
| Michigan | - | - | - | - | - | - | - | - | - | 302 | 142 | 42,777 | 351,087 |
| Minnesota | - | - | - | - | - | - | - | - | - | 28 | 255 | 7,148 | 57,182 |
| Mississippi | - | - | - | - | - | - | - | - | - | 67 | 284 | 19,002 | 152,736 |
| Missouri | - | - | - | - | - | - | - | - | - | 41 | 249 | 10,218 | 81,191 |
| Montana | - | - | - | - | - | - | - | - | - | 43 | 260 | 11,164 | 89,314 |
| Nebraska | - | - | - | - | - | - | - | - | - | 4 | 300 | 1,200 | 9,600 |
| Nevada | - | - | - | - | - | - | - | - | - | 139 | 257 | 35,791 | 286,332 |
| New Hampshire | - | - | - | - | - | - | - | - | - | - | - | - | - |
| New Jersey | - | 1 | 1 | - | 11.66 | 11.66 | - | 82 | 82 | 43 | 252 | 10,853 | 85,732 |
| New Mexico | - | - | - | - | - | - | - | - | - | 151 | 296 | 44,709 | 355,981 |
| New York | - | - | - | - | - | - | - | - | - | 210 | 261 | 54,828 | 438,363 |
| North Carolina | - | - | - | - | - | - | - | - | - | 64 | 264 | 16,884 | 138,017 |
| North Dakota | - | - | - | - | - | - | - | - | - | 4 | 230 | 920 | 7,360 |
| Ohio | - | 1 | 1 | - | 1.82 | 1.82 | - | 15 | 15 | 264 | 265 | 69,881 | 548,730 |
| Oklahoma | - | - | - | - | - | - | - | - | - | 30 | 242 | 7,265 | 56,983 |
| Oregon | - | - | - | - | - | - | - | - | - | 9 | 216 | 1,948 | 15,468 |
| Pennsylvania | - | 1 | 1 | - | 5.53 | 5.53 | - | 1,112 | 1,112 | 89 | 261 | 23,264 | 180,755 |
| South Carolina | - | 1 | 1 | - | 9.45 | 9.45 | - | 236 | 236 | 50 | 265 | 13,231 | 105,848 |
| South Dakota | - | - | - | - | - | - | - | - | - | 11 | 273 | 2,998 | 23,984 |
| Tennessee | - | - | - | - | - | - | - | - | - | 33 | 262 | 8,645 | 70,446 |
| Texas | - | - | - | - | - | - | - | - | - | 148 | 226 | 33,380 | 266,934 |
| Utah | - | - | - | - | - | - | - | - | - | 64 | 283 | 18,119 | 144,852 |
| Vermont | - | - | - | - | - | - | - | - | - | 21 | 245 | 5,155 | 41,238 |
| Virginia | - | - | - | - | - | - | - | - | - | 47 | 260 | 12,225 | 95,454 |
| Washington | - | - | - | - | - | - | - | - | - | 5 | 258 | 1,290 | 9,570 |
| West Virginia | - | - | - | - | - | - | - | - | - | 326 | 269 | 87,676 | 701,204 |
| Wyoming | - | - | - | - | - | - | - | - | - | 103 | 258 | 26,608 | 213,257 |
| Total or average | - | 4 | 4 | - | .45 | .45 | - | 27 | 27 | 4,363 | 252 | 1,099,252 | 8,800,874 |

IC bureau of mines information circular 8482



# SUMMARY OF MINING AND PETROLEUM LAWS OF THE WORLD

(In Five Parts)

1. Western Hemisphere

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1970

# SUMMARY OF MINING AND PETROLEUM LAWS OF THE WORLD

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* * * * * * * * * * * information circular 8482

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## FOREWORD

This Summary of Mining and Petroleum Laws of the World represents a cooperative effort of the author and the Bureau of Mines that has extended over many years. Culminating research that began in the early 1950's, the original Summary was published as Bureau of Mines Information Circular 8017 in 1961. The dynamic mineral resource developments and new administrative policies adopted by many countries during the subsequent decade called for updating the material. The author, Northcutt Ely, is regarded as a leading authority in the field of international minerals legislation. His long experience with the legal aspects of natural resource development has been recognized by national and State administrative agencies in the United States. His guidance and counsel have been adopted in several countries that have undertaken revision or modernizing of their mineral codes or minerals regulation policies.

For maximum distribution flexibility, this revised Summary of Mining and Petroleum Laws of the World is being issued in five parts. Global coverage will be achieved in Information Circulars covering each of the major geographical jurisdictions: Western Hemisphere, Europe, Africa, Near East and South Asia, and East Asia and the Pacific.

As the title implies, condensation of official legal documents has been extensive; only major features of the various laws are given. In this context the investor or operator contemplating activity in any foreign country is urged to seek qualified legal counsel, preferably in the country of his interest. Not only are mining codes subject to change, but laws that control corporate structure, labor, taxation, and monetary regulations as well as local habits and customs will have significant effect on a mining or petroleum venture. Information on these can only be obtained by functional experience and direct communication with appropriate regulatory agencies. Where readily available, Mr. Ely has included names and addresses of suggested correspondents in footnotes and bibliographic references.

Director

# CONTENTS

# SUMMARY OF MINING AND PETROLEUM LAWS OF THE WORLD

(In Five Parts)

1. Western Hemisphere

by

Northcutt Ely[1 2 3]

## ABSTRACT

This volume summarizes mining and petroleum legislation in 30 jurisdictions of the Western Hemisphere. Within these jurisdictions, primary attention is given to requirements that must be met in each country for acquisition of rights to permit development of mineral resources. Coverage includes: First, identification of the controlling laws or statutes governing minerals acquisition and reference to the administrative authority; second, analysis of the laws governing mines and quarries and their products; and third, analysis of laws applicable to natural gas, petroleum, and related materials. Where pertinent, sections dealing with historical background or administration have been added. In countries where minerals are subject to control of States or Provinces, those areas are considered separately from the central government.

## INTRODUCTION

This Bureau of Mines circular is the first of a five-part series revising the "Summary of Mining and Petroleum Laws of the World" published as Information Circular 8017 in 1961. The author has sought to include all significant legislation applicable to minerals in each national jurisdiction. Instances where this goal has not been fulfilled are due to lack of available source material, as in the case of Cuba, or to apparent insignificance of the area as a present or potential producer of minerals. Other omissions include small colonial or territorial areas whose mineral policies are administered under laws of the mother country.

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[1] Senior partner of the law firm of Ely and Duncan, Washington, D.C., and member of the Bar of the United States Supreme Court, the States of California and New York, and the District of Columbia.

[2] Albert T. Chandler and Donald R. Allen were in charge of the staff work. Robert J. Liset, Eugene Joseph Gillespie, Jr., Kevin P. Conway, J. William Colbert III, E. T. Hunt Talmage III, and Jean-Claude Petilon collaborated in the research and assisted in compiling this manuscript.

[3] Lester G. Morrell, mining engineer, Bureau of Mines, adapted the original manuscript for Federal publication.

Summaries of laws of the individual nations are necessarily brief, having been condensed for the most part from a great volume of original material, much of it translated from a foreign language. While the latest material has been sought, new laws and regulations are continually being enacted. For these reasons a caveat is appropriate; this text is intended only as an outline, or guide. The reader who is concerned with investment or working conditions in a country is advised to ascertain the latest detailed provisions of laws currently in force and seek assistance of counsel experienced in local jurisprudence.

In this volume, the Western Hemisphere has been treated in three geographical subdivisions: North America, Central America including the Caribbean Islands, and South America. Within these groupings, the nations are arranged in alphabetical order.

Historically, U.S. and Canadian mineral laws reflect a common origin in British common law concepts. Mineral rights passed with the surface estate, and consequently many mineral deposits are now privately owned. Early mining laws in the Western United States and in Canada featured the location principle whereby the discoverer of a mineral deposit acquired mineral rights by staking and recording a claim. Claims were maintained by working the prospect, and subsequently title to the deposit and surface estate could be acquired. The right to a mineral title has been replaced by a right to lease in Canada and with respect to certain minerals and certain classes of land in the United States. Under these leasing systems, the mineral estate is severed from that of the surface. Leasing laws originally designed to govern petroleum development have been gradually broadened to govern other minerals. However, in the United States the location principle has been retained for most hard minerals, thus making possible the passage of fee title to both minerals and surface upon payment of nominal sums, following discovery of minerals.

Throughout Latin America mining laws are relatively uniform owing to their common origin in Spanish legislation. Early 16th century settlers used Spanish laws. Later special rules, such as Las Ordenanzas del Nuevo Cuaderno (The Ordenances of the New Book) promulgated in 1584 by Philip II, were designed for the Spanish colonies. These rules were characterized by separation of mineral deposits from surface real estate. Minerals were declared the King's patrimony. Initially, rights to minerals in state areas (pertenencias) were dowed by the Crown to anyone who made a discovery and filed a formal claim (denouncement). The surface owner had no prior right to minerals found on his land. Major conditions for retaining mineral rights were working the deposit, as evidenced by royalty payments, minimum annual production, or payment of an annual fee. Following independence, many Latin American countries enacted exceptions to acquisition of mineral rights by denouncement. Some substances were reserved to the state, and their development was required to be carried out through concession contracts. Others, primarily building materials, were reserved to the owner of the surface estate. Today most Latin American mining laws classify minerals as subject to (1) concession systems, (2) denouncement, or (3) priority rights of surface owner.

Throughout this book values of national currency units are given in terms of U.S. dollars according to International Monetary Fund Schedule of Par Values, 48th issue, Washington, D.C., January 5, 1970.

ACKNOWLEDGMENTS

The author is greatly indebted for the invaluable assistance and comments received from a large number of Government officials, scholars, representatives of private industry, and members of the Bar engaged in mineral law problems of the various jurisdictions studied. In particular the author wishes to acknowledge the following:

Bureau of Mines, Department of the Interior, Washington, D.C.

Department of State, Washington, D.C.

Bureau of International Commerce, Department of Commerce, Washington, D.C.

Public Land Law Review Commission, Washington, D.C.

General Legal Division, Department of Legal Affairs of the Pan American Union.

Deputy Minister, Department of Energy, Mines and Resources, Ottawa, Canada.

Deputy Minister, Department of Indian Affairs and Northern Development, Ottawa, Canada.

Deputy Minister, Department of Mines and Petroleum Resources, Victoria, British Columbia, Canada.

Deputy Minister, Department of Mines and Minerals, Edmonton, Alberta, Canada.

Deputy Minister, Department of Mineral Resources, Regina, Saskatchewan, Canada.

Director, Mines Branch, Department of Mines and Natural Resources, Winnipeg, Manitoba, Canada.

Deputy Minister, Department of Mines, Toronto, Ontario, Canada.

Deputy Minister, Department of Energy and Resources Management, Toronto, Ontario, Canada.

Deputy Minister, Department of Natural Resources, Quebec, Quebec, Canada.

Assistant Deputy Minister (Mines), Department of Natural Resources, Fredericton, New Brunswick, Canada.

Deputy Minister, Department of Mines, Halifax, Nova Scotia, Canada.

Deputy Minister, Department of Industry and Natural Resources, Charlottetown, Prince Edward Island, Canada.

Director of Mineral Resources, Department of Mines, Agriculture and Resources, St. John's Newfoundland, Canada.

Director of Exploration, Industrias Peñoles, S.A., Mexico City, Mexico.

Secretary, Ministry of Trade and Labour, Bridgetown, Barbados.

Permanent Secretary, Ministry of Natural Resources and Trade, Belize City, British Honduras.

Departamento de Geologia, Minas y Petroleos, Ministerio de Industrias, San Jose, Costa Rica.

Direccion de Mineria, Secretary of Industry and Commerce, Santo Domingo, Dominican Republic.

Departmento de Promocion Economica y Asuntos Industriales, Ministerio de Economia, San Salvador, El Salvador.

Monsieur le Chef du Service des Mines, Cayenne, French Guiana.

Direccion General de Mineria e Hidrocarburos, Guatemala, Guatemala.

Service de Geologie et des Mines, Department de l'Agriculture, des Ressources Naturelles and de Developpement, Rural, Port-au-Prince, Haiti.

Direccion General de Recoursos Naturales, Tegucigalpa, D.C., Honduras.

Department of Mines, Hope, Kingston, Jamaica.

Servicio Geologico National, Ministerio de Economia, Managua, Nicaragua.

Administration of Mineral Resources, Ministry of Commerce and Industry, Panama, Panama.

Mining Commission, Office of the Governor, San Juan, Puerto Rico.

Chief Technical Officer, Ministry of Petroleum and Mines, Port of Spain, Trinidad, Trinidad and Tobago.

Direccion Nacional de Geologia y Minera, Buènos Aires, Argentina.

Direccion General de Minas, Ministerio de Minas y Petroleo, La Paz, Bolivia.

Divisao de Fomento da Producao Mineral, Departmento Nacional da Producao Mineral, Rio de Janeiro, Brazil.

Servicio de Minas, Ministero de Mineria, Santiago, Chile.

Division de Minas, Ministerio de Minas y Petroleos, Bogota, Colombia.

Direccion General de Minas e Hidrocarburos, Ministry of Industry and Commerce, Quito, Ecuador.

Commissioner of Lands and Mines, Ministry of Agriculture and Natural Resources, Georgetown, Guyana.

Director, Direccion de Produccion Minera, Ministerio de Obras Publicos y Communicaciones, Asuncion, Paraguay.

Bureau of Mines and Bureau of Hydrocarbons, Ministry of Energy and Mines, Lima, Peru.

Surinam Government Geological and Mining Service, Paramaribo, Surinam.

Inspeccion General de Minas, Ministry of Industry and Commerce, Montevideo, Uruguay.

Consultor, Juridico, Ministerio de Minas e Hidrocarburos, Caracas, Venezuela.

Director, Comision de Fomento Minero, Mexico City, Mexico.

# CANADA

## Mineral Titles

Titles to minerals on Crown (public) lands are vested in the Provincial governments, except in the Northwest Territories, the Yukon, and lands constituting Indian Reserves and National Parks where title is held by the Federal Government. Each of the 10 Provincial governments has its own mineral laws applicable to the disposition of mineral rights, conservation measures, mineral taxation and royalties, operating and safety rules, and other controls on mineral industries. There are also important Federal laws applicable to mineral activities in the Provinces.

Some mineral rights are owned privately as a result of past practices of granting mineral titles upon satisfaction of specified development work, and granting titles to land including mineral rights. The production of minerals on such lands is subject to laws dealing with operating practices, conservation, and mining taxes. In some cases title to these private mineral rights may be reclaimed by the Crown if no development work has been carried out for a period of years.

Mineral titles are now granted independently from surface rights in all parts of Canada. Permission to utilize surface land, timber, and water may be obtained to the extent required for mining operations. Extra-lateral rights are not included in mineral titles.

As a general rule, any individual over 18 years of age and any company authorized to do business in Canada may acquire rights to minerals on Crown lands in all Provinces and Territories.[1] For minerals other than gas, rights are generally initiated by staking claims, and maintenance of claims depends upon performance of annual assessment work. Making a discovery is not a requirement for staking a claim. It is generally possible to obtain exclusive prospecting rights for remote areas. Mining is carried on under leases, except in Ontario where it is still possible to obtain title to mineral lands by patent.

The Department of Energy, Mines and Resources[2] administers the Federal laws of general application throughout Canada. This Department carries out geological surveys, investigates mines and mineral deposits, and publishes statistics and maps. The National Energy Board, Atomic Energy Control Board, and Dominion Coal Board exercise important functions concerning mineral development.

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[1] There are exceptions to this rule. In the Northwest Territories, leases may be held only by Canadian citizens or companies incorporated in Canada with 50 percent Canadian ownership or with specified opportunities for Canadian participation (Canada Mining Regulations, P.C. 1961-325). In Newfoundland and Quebec, there are requirements that companies be incorporated in Canada.

[2] For information, write Deputy Minister, Department of Energy, Mines and Resources, Ottawa, Canada. Copies of acts may be purchased from the Queen's Printer, Ottawa, Canada.

## Taxation[3]

The Federal income tax laws impose the largest tax burden on the mineral industry, although these laws allow the industry substantial benefits as incentives. Although all the Provinces have their own income tax acts, the Federal Government, under federal-provincial tax-sharing agreements, collects all personal and corporation income taxes (with two exceptions) in Canada and then rebates portions to the various Provinces. The exceptions are Ontario and Quebec: Ontario collects its own corporation income taxes, while Quebec collects both its own personal and its own corporation income taxes. In these two Provinces, these taxes are taken into consideration when computing Federal income tax.

All of the Provinces and the two Territories directly assess the mineral industry within their respective boundaries for mining taxes and/or royalties at various rates and under different laws. The mining taxes, which are in addition to income taxes, are deductible within limitations in determining Federal income taxes. Royalties, which are levies on a unit of production basis, are wholly deductible in Federal income tax computations.

Income from most mines, but not from oil and gas wells, is entirely exempt from income tax for the first 3 years after reasonable production commences. Prospecting, exploration, and development expenses can be deducted from income. There are carry back-carry forward restrictions on losses.

Most mines and oil and gas wells are permitted a depletion allowance of 33-1/3 percent in computing taxable income, and such deduction prevails as long as production continues. The deduction is applicable after almost all other permissible deductions have been applied. Prospectors and their financial backers are exempt from tax on certain income derived from the sale of mining properties acquired as the result of their prospecting activities.

Nonresidents who receive dividends from corporations operating in Canada pay a withholding tax of 15 percent of the dividends in lieu of income taxes. This tax is withheld by the corporation paying the dividend. If the corporation has a sufficient degree of Canadian ownership, the withholding tax is reduced to 10 percent.

Mining machinery and equipment, in many cases, is exempt from duties imposed under the Customs Tariff. The exemption does not apply to classes and kinds of machinery and equipment which are made in Canada. The Federal sales tax, imposed under the Excise Tax Act, does not apply to most items of machinery and equipment used in production processes, including mining.

A recent White Paper on Tax Reform (made public November 7, 1969) proposes some major changes, such as the introduction of a capital gains tax. The paper recognizes that incentives previously given mining companies to compensate for the high risks of exploration and development should be maintained.

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[3] Principal Federal tax legislation includes the Income Tax Act and Regulations, the Excise Tax Act, and the Customs Tariff. See Mineral Information Bulletin MR 101, Mineral Resources Branch, Department of Energy, Mines and Resources, Ottawa.

The depletion allowance would remain at the present rate, but hereafter would be restricted to 33-1/3 percent of accumulated capital expenditures and exploration and development costs. The cost of acquiring petroleum rights would remain deductible and would be extended to include the cost of other mineral rights. The 3-year tax exemption presently granted new mines would be replaced by a provision permitting a developing company full recovery of its investment in a new mine before the income from that mine became taxable.

## Northwest Territories and the Yukon Territory

The Territorial Lands Act, R.S.C. 1952, authorizes the making of regulations to govern the disposal of mineral rights in the Northwest Territories. Regulations applicable to mining in the Northwest Territories are Canada Mining Regulations, P.C. 1961-325, as amended. The following mining laws are in effect in the Yukon Territory: Yukon Quartz Mining Act, R.S. 1952, Ch. 217; and Yukon Placer Mining Act, R.S. 1952, Ch. 216. The Canada Oil and Gas Land Regulations, P.C. 1961-797, as amended, apply to both the Yukon Territory and the Northwest Territories, as do P.C. 1967-2227, Territorial Coal Regulations, and P.C. 1954-1920, Territorial Dredging Regulations.

The Department of Indian Affairs and Northern Development[4] is responsible for administration of these laws.

### Mining: Northwest Territories

#### Prospector's License

A license gives the right to stake claims and to prospect and develop mineral lands. A licensee may stake no more than 36 claims in 1 year within the area shown on a mineral claim staking sheet (based on the National Topographical System). The area of a claim may not exceed 51.65 acres (1,500 feet by 1,500 feet). Claims may be recorded within 40 to 60 days, and may be held up to 10 years. The annual work requirement to maintain a claim is $100. (Can$1 = US$0.925.) An extension of time to do work may be granted upon receipt of a work performance bond.

#### Prospecting Permit

Upon application, an exclusive permit will be granted for a period of 3 years to prospect and stake claims in remote areas. The minimum work requirement increases from 10 cents per acre in the first year to 40 cents per acre in the third year. One-quarter of the permit area must be released after the first year, and another one-quarter after the second year.

#### Lease

A lease of a mineral claim may be acquired after 5 years if the required assessment work has been performed, or at any time if production exceeds

[4] For information, write Deputy Minister, Department of Indian Affairs and Northern Development, Ottawa, Canada.

5 tons per day. The lease has a term of 21 years and is renewable. Leases are granted only to Canadian citizens, or to companies incorporated in Canada with (1) 50 percent ownership held by Canadian citizens, or (2) shares listed on a Canadian stock exchange. A mine is exempt from royalty for the first 3 years after production starts. Thereafter, a progressively increasing royalty is payable, ranging up to 12 percent on the value of production. The value of production is defined as actual market value less operating costs, depreciation, and other deductions.

## Mining: Yukon Territory

The Yukon Quartz Mining Act applies to minerals in place. The Yukon Placer Mining Act applies to every method of mining of alluvial deposits to obtain gold or similar precious minerals or stones.

### Minerals Claims

Any person 18 years of age or over may prospect and locate mineral claims. No license is required.

The maximum area of quartz claims is 51.65 acres (1,500 feet by 1,500 feet). Claims must be recorded. The annual work requirement is $100, and payment in lieu of work is accepted. The holder of a claim has the right to mine without having to acquire a lease. The claim holder is entitled to a certificate of improvement upon completion of $500 work, or payment in lieu of work, if he has discovered a vein or lode.

Placer claims may have a length of 500 feet, except in the case of a discovery claim (first recorded claim on a creek or bench), which may have a length of 1,500 feet. Claims must be recorded. The annual work requirement is $200. A person may not locate more than one placer claim in his name within the valley or basin of the same creek or river within 60 days. A claim holder may obtain a grant of the claim for 1 to 5 years and renewals from year to year.

### Leases on Mineral Claims

A certificate of improvement gives the holder of a quartz claim the right to a lease. A lease has a term of 21 years and is renewable. An annual royalty is payable on profits, ranging up to 6 percent, and increasing another 1 percent for each additional $5 million above $10 million.

## Petroleum: Northwest Territories and the Yukon Territory

### Exploratory License

A license entitles the holder to search for petroleum by geological and geophysical methods, and to carry out subsurface investigations to a depth of less than 1,000 feet. A license may be issued to any person who has reached an age of 21 years or to a company authorized to do business in Canada.

Exploratory Permit

Permits are issued for grid areas based on the N.W.T. and Y.T. Grid System. A permit has a term of 3, 4, or 6 years, depending on its location, and is renewable for 1-year terms. Permits are issued through application or public tender. Work requirements increase from 5 cents to 50 cents per acre per term during the life of the permit.

Oil and Gas Lease

A lease must be obtained before commercial production starts. A permittee may acquire leases covering up to 50 percent of his permit area, and leases on the remaining area by paying a higher royalty. A lease has a term of 21 years and is renewable. Generally, a royalty of 5 percent of market value of production is payable for the first 3 years of commercial production, and 10 percent thereafter. Rates vary on leases carrying extra royalty requirements.

## British Columbia

The controlling laws are the Mineral Act[5] and the Petroleum and Natural Gas Act, 1967.[6] The Department of Mines and Petroleum Resources is responsible for administration of laws relating to mineral titles of all minerals except certain industrial materials.[7] The Petroleum and Natural Gas Branch of the Department administers the conservation provisions of the Petroleum and Natural Gas Act.

### Mining

The system of issuing mineral rights in fee simple through Crown grants was replaced in 1957 by a system of leasing mineral rights.

Free Miner's Certificate

A certificate must be acquired before a person can prospect for, locate, and record mineral claims. There is no limit to the number of claims that can be located. The area of a claim may not exceed 51.65 acres (1,500 feet by 1,500 feet). Claims must be recorded within 15 to 30 days of staking. Claims may be held as long as annual work worth $100 is performed, or an annual payment of $100 is made in lieu of work. The Mineral Act permits the grouping of up to 40 mineral claims to be worked as a unit.

Mineral Lease

Upon completion of $500 assessment work, or payment of $500 cash in lieu of work, and survey of the claim, the holder may apply for a certificate of

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[5] R.S.B.C. 1960, Ch. 244 and amendments.

[6] S.B.C. 1967, Ch. 33.

[7] For information, write Deputy Minister, Department of Mines and Petroleum Resources, Victoria, British Columbia. The Department publishes "Synopses of the Laws Relating to the Mineral Industry of British Columbia," which is a digest of the Mineral Act, the Placer-Mining Act, and related laws.

improvement and a mineral lease. A lease has a term of 21 years and is subject to annual rental payments and annual assessment work requirements, both of which are based on acreage.

The Placer-Mining Act, 1960,[8] governs location of minerals occurring in any natural unconsolidated material. There are three types of placer claims: creek diggings, bar diggings, and dry diggings. Leases of up to 80 acres are granted for terms not exceeding 20 years by the Gold Commissioner of the mining division in which the property is located.

The Mineral Act authorizes levying royalties on mineral production, but the only royalty imposed to date is on iron ore. All mining companies are liable for a provincial 15 percent net income tax after the first $10,000 income. An acreage tax is imposed on Crown granted claims when less than $200 annual development work per claims is done.[9]

## Petroleum

### Exploration Permit

A permit gives rights to carry out geological and geophysical work and exploratory drilling within the permit area. Permits are issued for grid areas or subdivisions thereof. A grid area comprises 15 minutes of latitude and 15 minutes of longitude. Permits are held from year to year and are subject to annual fees and annual rentals, which are based upon the accessibility and terrain and performance of work requirements. Minimum expenditure requirements during the term of the permit increase from 5 cents to 75 cents per acre per year, depending upon the class of permit which is based on accessibility and terrain.

### Geophysical License

A license is required to undertake geophysical exploration.

### Natural Gas License

This license gives the right to obtain leases for natural gas discovered in the zones or geological horizons included in the license.

### Petroleum and Natural Gas Lease

The holder of a permit may apply for leases covering up to 50 percent of his permit area on a checkerboard pattern. The remaining 50 percent of the area becomes a Crown reserve, which may be offered for sale to the highest bidder. A lease must be obtained before commercial production starts. It is valid for 10 years and renewable if the lease is capable of production. Royalty rates on crude oil range from 5 to 16-2/3 percent, depending on rate of production.

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[8] R.S.B.C. 1960, Ch. 285.
[9] Taxation Act, R.S.B.C. 1960, Ch. 376.

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## Drilling Reservation

A reservation gives the right to do exploratory work and drilling in Crown reserves, and to apply for leases subject to the conditions set forth in the reservation.

### Alberta

The controlling law is the Mines and Minerals Act, 1962.[10] Part V of this act governs petroleum and natural gas. The Department of Mines and Minerals[11] is responsible for granting mineral rights and collecting revenues. The Oil and Gas Conservation Board is responsible for well licensing and for regulating practices for drilling and production of petroleum under The Oil and Gas Conservation Act, 1969.[12]

#### Mining

Regulations under the 1962 act were promulgated in 1967 for quartz mining, and claims now comprise quarter sections or what would be quarter sections if the lands were so surveyed. Quartz minerals do not include salt, sulfur, coal, petroleum, natural gas, oil sands, quarriable stone, or clay. There is no requirement for staking or for assessment work, and there is no restriction of the number of claims a person or company may hold. A claim may be held for 5 years at an annual fee of $50 and for a further 5 years at an annual fee of $160, payable yearly in advance.

Exploration permits are granted for 1 year for a fee of $125 and a deposit of $1,000 for each 10,000 acres or portion thereof applied for. The maximum area of a permit is 50,000 acres, and it may be continued for a second year at 10 cents per acre and for a third year at 15 cents per acre. If the approved plan of examination is conducted, the deposit is refunded and leases of all or any portion of the area may be obtained. The term of a lease is 21 years, renewable for further terms of 21 years each so long as quartz minerals are being produced.

Anyone holding a mineral claim or mineral claims within a radius of 10 miles may convert to a lease. The annual rental for a lease is $1 per acre, and the royalty is 12-1/2 percent of the products recovered.

The province reserves the right in article 31 of the Mines and Minerals Act to receive a royalty on all minerals. Under the Mineral Taxation Act,[13] provision is made for a mineral acreage tax (maximum rate of 5 cents per acre), and a producing area tax which is based on the assessed value of minerals in the producing area.

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[10] S.A. 1962, Ch. 49.

[11] For information, write Deputy Minister, Department of Mines and Minerals, Edmonton, Alberta, Canada.

[12] S.A. 1969, Ch. 83. New Oil and Gas Conservation Regulations, Alberta Regulations, Alberta Regulation 183/69 came into force on July 1, 1969.

[13] R.S.A. 1955, Ch. 203.

## Petroleum

### Reservations

A reservation grants the right to drill for and to produce petroleum and natural gas. A reservation has an initial term of 4 months, with six renewals. When drilling is undertaken, six further renewals of 3 months each are authorized. The holder of a reservation may obtain a lease for not more than 50 percent of the reservation area.

### Drilling Reservation

A reservation gives the right to drill in Crown reserves and to apply for leases on approximately one-quarter of the area subject to the conditions set forth in the reservation.

### Permits

A permit grants the same rights as a reservation, but the holder may acquire leases on 100 percent of the permit area. Permits are issued in townships 1 to 64, west of the 4th meridian and are limited to 23,040 acres; reservations are issued in the rest of the province.

### Natural Gas License

This license grants to the holder of a reservation or permit the right to drill for and produce natural gas. A license has a term of 6 months and may be renewed five times. The area held under a license is limited to 23,040 acres.

### Lease

A lease grants the right to produce petroleum and natural gas. A lease has a term of 10 years and continues as long as it is capable of production. The maximum area of a lease is 5,760 acres. A number of areas have been designated "Crown Reserves." Petroleum rights in these reserves are disposed of by public offerings of leases, drilling reservations, natural gas licenses, and ordinary reservations. Royalty rates on crude oil range from 8 to 16-2/3 percent, depending on the rate of production. Royalty on natural gas is 16-2/3 percent of wellhead value.

## Saskatchewan

The controlling law is The Mineral Resources Act, which applies to all minerals. The Department of Mineral Resources[14] administers the act and regulations thereunder.

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[14] For information, write Deputy Minister, Department of Mineral Resources, Regina, Saskatchewan.

## Mining

### Claims

Under the Mineral Disposition Regulations, 1961, no permit or license is required for any person to stake claims or claim blocks. A claim consists of one legal subdivision in surveyed areas and may not exceed 40 acres in unsurveyed territory. The minimum annual assessment work is $100 after the first year. A claim block consists of between 960 and 15,360 acres, for which the minimum annual assessment work is $2.50 per acre. All claims must be recorded. A holder of a claim has an exclusive right to prospect for minerals for not more than 10 years, provided that the required assessment work is carried out.

### Permit

The Minister may grant a 3-year permit with two extensions of 1 year each, giving exclusive rights to prospect for minerals in an area of between 36 and 300 square miles, for an annual rental of 2 cents per acre or $1,000, whichever is greater. Minimum annual assessment work ranges from $30,000 for the first year to $60,000 for the fifth year.

### Lease

A lease has a term of 21 years and is renewable for 21 years. The minimum annual assessment work is $5 per acre. When production starts, or upon expenditure of $50,000 in underground mining, the annual work requirement may be relaxed. Proof of performance of assessment work must be recorded annually. Leases are granted to holders of claims, claim blocks, and permits. A royalty is payable on the net income of mines at the rate of 12-1/2 percent, except that in the case of new mines the rate ranges from 0 to 9 percent after a 3-year exemption period.

## Petroleum

The Petroleum and Natural Gas Regulations, 1969, provide for three types of petroleum rights, which are disposed of by bonus bidding. The Oil and Gas Conservation Board acts in an advisory capacity to the Minister in administering The Oil and Gas Conservation Act.

### Exploratory Permit

Permits are granted for not more than 100,000 acres for terms of 5 years. Permits are subject to progressively increasing surface rentals (2 cents to 10 cents per acre), and progressively increasing work requirements (20 cents per acre or $10,000, whichever is greater, to 60 cents per acre). The holder of a permit has an exclusive right to lease lands included in the permit area upon discovery of oil or gas in commercial quantities.

### Drilling Reservation

Areas comprising drilling reservations are offered for exploration purposes by cash bonus bids. Reservations have a duration of 1 year, may be

renewed twice, and are subject to an annual rental. Upon making a commercial discovery, a lease will be granted for not more than 50 percent of the reservation area.

Lease

Leases are disposed of by sale in addition to grants to holders of permits and reservations. A lease has a term of 10 years and is renewable for 10-year periods. Royalties range from 5 to 16 percent on production of oil and are 8 percent for natural gas.

## Manitoba

The controlling statute is the Mines Act, 1954.[15] The Mines Branch of the Department of Mines and Natural Resources[16] is responsible for granting all mineral rights. The Oil and Gas Conservation Board has broad regulatory powers over petroleum operations.

### Mining[17]

Miner's License

A licensee has the right to stake out an unlimited number of claims or blocks in each mining division each year. A claim is generally in the form of a square with 1,500-foot sides and must be recorded within 15 to 60 days. A claim block may be up to 18 claims in size. Assessment work may include removal of 144 cubic feet of rock underground, removal of 288 cubic feet of overburden, 35 feet of diamond drilling, a survey of the claim, or an approved geological or geophysical survey. A lease will be granted upon completion of 5 years of assessment work, including a survey. Assessment work is not required for placer claims.

Prospector's Reservation

A licensee who makes the first discovery in specified parts of the province may obtain a prospector's reservation for an area 2 miles square, within which he shall have exclusive staking rights for 6 months.

Geophysical Reservation

Lands may be reserved for 18- to 30-month periods while carrying out geophysical surveys or other approved exploration. The area which may be reserved is between 10,000 and 200,000 acres. During the period of a reservation, the holder may stake claims covering not more than 50 percent of the area or 50,000 acres.

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[15] R.S.M. 1954, Ch. 166.

[16] For information, write Director, Mines Branch, Department of Mines and Natural Resources, Winnipeg, Manitoba, Canada.

[17] See Regulations for the Disposal of Mining Claims and Placer Claims and Regulations Governing the Operation of Mines in Manitoba.

Lease

A lease has a term of 21 years and is renewable for two 21-year periods if production is underway. The surface rental is generally $1 per acre. A royalty tax, ranging from 6 to 11 percent is levied on net profits, but there is a 50-percent reduction in this tax during the first 3 years of production from new mines.[18]

## Petroleum[19]

Geological and Geophysical License

This license is required in order to carry out geological and geophysical studies. Monthly progress reports must be filed.

Geological and Geophysical Reservation

Areas of land not exceeding 200,000 acres may be reserved while geological and geophysical studies are being carried out. Fees are $250 plus a deposit of between $750 and $2,000 for each 20,000 acres. A reservation has a term of 1 year and is renewable under certain conditions. The holder has a right to apply for leases up to 50 percent of the area of the reservation.

Drilling Reservation

A drilling reservation may not exceed 10,000 acres. The reservation has a term of 60 days, renewable for 60-day periods upon making satisfactory progress. The holder has an exclusive right to leases on all or part of the area of the reservation.

Lease

A lease has a term of 3 years, with a secondary term of 6 years, and is renewable for successive 6-year periods as long as production continues. The area of a lease may not exceed 1,920 acres. Royalty is 12-1/2 percent on the value of oil and natural gas produced.

Special provisions govern operations in the northern portion of the province where exploration permits may be issued. Leases are granted by application (limited to 1/2 the permit area) or by tender. The southwestern portion of the province is also governed by a special provision of the Mines Act--Regulation 46/65. In many aspects it is similar to the other provisions of the act.

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[18] The Mining Royalty and Tax Act, 1954, Ch. 169.
[19] Regulations for the Disposal of Oil and Natural Gas Rights on Crown Lands and the Exploration, Development and Production of Oil and Natural Gas, Manitoba Regulation 14/47, as amended.

## Ontario

The controlling statute is the Mining Act of 1960.[20] The Department of Mines[21] is responsible for administration of the act, but in 1960 the Department of Energy and Resources Management was established with powers over the development of oil and natural gas resources.[22] Rights to all minerals including petroleum and natural gas may be acquired by staking.

### Mining

#### Miner's License

This license authorizes prospecting and staking on the Crown lands. There is no limit to the number of mining claims that may be staked. The area of a claim is 40 acres in unsurveyed territory, and a legal subdivision in surveyed territory. Claims must be recorded within 31 days of staking, and after 60 days have elapsed and a survey has been made, the recorder can issue a certificate of record. The holder may obtain a lease if 200 days' work is performed within 5 years. Payment in lieu of assessment work is not permitted.

#### Leasehold and Freehold Patents

A leasehold patent has a term of 21 years, renewable for successive terms of 21 years at the discretion of the Minister. If mineral production has been continuous for more than 1 year, a freehold patent may be obtained upon payment of the purchase price. An acreage tax of 50 cents per acre is payable on patented claims. A tax of 15 percent is levied on net profits.[23]

### Petroleum

Natural gas and petroleum are considered to be minerals and can be included in mining claims.

Exploration in the Great Lakes is under Regulation 440. Exploratory licenses up to 5,120 acres are available upon application. Work to the value of approximately $20,000 is required over a 3-year period. Leases are issued upon proof of a commercial discovery. Royalty is 10 percent, less the rental.

North of the 51st degree of latitude, new regulations are in course of preparation. They will be similar to those in use in the Northwest Territories and will provide for 3-year exploratory licenses of approximately 70,000 acres based on geographic coordinates. There will be provision for extending the term and for converting 50 percent of the area to lease on proof of a commercial discovery.

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[20] R.S.O. 1960, Ch. 241.
[21] For information, write Deputy Minister, Department of Mines, Toronto, Ontario.
[22] For information, write Deputy Minister, Department of Energy and Resources Management, Toronto, Ontario.
[23] The Mining Tax Act. R.S.O. 1960, Ch. 242.

## Quebec

The controlling statute is the Mining Act of 1965, S.Q. 1965 (1st Session, Ch. 34), amended by S.Q. 1968, Ch. 36. Regulations passed by Order in Council No. 428, March 9, 1968 (under sections 268 and 270 of the act) concern exploration permits to explore for mineral substances in alluvial deposits. The Department of Natural Resources is responsible for administration of the act.[24]

### Mining

#### Prospector's License

A license gives the right to stake out a maximum of 200 acres. An individual may hold six licenses at the same time. Each license entitles the holder to stake out five claims of about 40 acres each (maximum of 200 acres). Claims must be recorded within 15 to 30 days after staking. A claim is valid for 12 months, and after the holder performs 5 hours of manual labor per acre or the equivalent, he becomes eligible for a development license for not more than 225 acres.

#### Exploration Permit

In remote areas it is possible to acquire mineral rights without staking claims by applying for an exploration permit. A permit area may be between 25 and 150 square miles. The term of a permit may not exceed 10 years. The holder is entitled to a mining lease on not more than 10 percent of the permit area.

#### Development License

A license is valid for 1 year and is renewable. The annual surface rental increases from 25 to 75 cents per acre after 3 years. The annual work requirement is 5 hours of manual labor per acre or the equivalent. Payment in lieu of work is accepted.

#### Mining Lease

No more than 200 acres may be leased to the same individual during a 1-year period, except upon authorization from the Lieutenant-Governor in Council. The term of a lease may be between 5 and 20 years, and the lease may be renewed for 10-year periods. Mining operations must be started within 2 years. Annual rental is $1 per acre. A tax of up to 15 percent is levied on the annual profits of mines.[25]

#### Mining Concession

Prior to 1966, mineral rights were granted by a system of concessions and letters patent. Many of these concessions can be revoked under the Mining Act

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[24] For information, write Deputy Minister, Department of Natural Resources, Quebec, Quebec.

[25] Mining Duties Act, S.Q. 1965 (1st Session), Ch. 35.

of 1965 for failure to carry on mining work or failure to pay annual taxes in lieu of work.

Petroleum[26]

Exploration License

The area covered by a license may not exceed 60,000 acres. The term of a license is 5 years. Annual work requirements range from 20 cents per acre (minimum, $3,000) in the first year to $1 per acre (minimum, $15,000) in the fifth year. Upon making a discovery, the licensee may apply for leases for up to 50 percent of the licensed area.

Operating Lease

The area covered by a lease may be between 500 and 5,000 acres. The lease has a term of 20 years and is renewable for 10-year periods. The royalty rate ranges from 5 to 17 percent.

## New Brunswick

The controlling statutes are the Mining Act, Ch. 45, 1962, as amended, and the Oil and Natural Gas Act, Ch. 162, 1952, as amended by the Act of March 28, 1969. The Mines Branch of the Department of Natural Resources is responsible for administration of these laws.[27]

Mining

Prospecting License

A license is required in order to prospect and to stake claims. Any number of claims of 40 acres may be staked annually and must be recorded within 30 days from the time of staking. A claim evidenced by a certificate of record is valid for 1 year and may be renewed annually for a maximum of 4 years. Annual assessment work is measured in work days and ranges from 25 days for the first year to a total of 100 days prior to conversion to a mining license. Payment in lieu of work is accepted.

Mining License

The holder of a recorded claim will be granted a mining license after the required assessment work is performed and a survey is completed. A license area may not exceed 25 contiguous claims. A license which authorizes mining is valid for 1 year and may be renewed annually if work requirements (25 days per 40 acres) are satisfied.

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[26] 1968 amendments to the Mining Act require persons seeking to explore for, develop, and use underground reservoirs to obtain an "exploration license for underground reservoirs." These amendments also created two other new titles, "storage leases" and "disposal licenses."

[27] For information, write Assistant Deputy Minister (Mines), Department of Natural Resources, Fredericton, New Brunswick, Canada.

Mining Lease

A lease also gives the right to mine, but for a term of 21 years, and it is renewable. Area and work requirements are the same as for a license. A tax of up to 9 percent is levied on net income.

Reservation

Under special circumstances an exclusive prospecting right may be granted for designated areas by order of the Lieutenant-Governor-in-Council.

Petroleum

By the Act of March 28, 1969, the Lieutenant-Governor-in-Council is authorized to make regulations prescribing the method of granting the fees payable for, and the terms and conditions of, a lease or license; defining the kind and quantities of work acceptable; prescribing the area to be covered; prescribing the fees or rentals; and fixing the royalties payable. Other sections of the act provide for regulations of drilling and development of petroleum operations.

## Nova Scotia

Controlling statutes are the Mines Act, 1954,[28] and the Petroleum and Natural Gas Act, 1954.[29] The Department of Mines[30] is responsible for administration of these laws. Areas granted under license or lease are based on the National Topographic Maps. Each reference map is divided into mining tracts of approximately 1 square mile in area. Each mining tract contains sixteen 40-acre claims. Rights can only be obtained by application to the Registrar in the form prescribed. They are not initiated by staking.

Mining

Prospecting License

A license gives the right to prospect for specified minerals within 1 to 16 contiguous 40-acre claims. There is no limit on the number of licenses that may be applied for, but the number of licenses granted is at the discretion of the Minister. The license has a term of 1 year, and is renewable for 5 consecutive years if the minimum work requirement of 40 man-days per 40-acre claim is satisfied.

Mining Lease

A lease gives the right to mine a specified mineral and is usually granted to the licensee only after he has held the area for at least 1 year. The area of a lease may include 1 to 16 contiguous claims. The lease has a term of 20 years and is renewable if work requirements are satisfied. The

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[28] R.S.N.S. 1954, Ch. 179.
[29] R.S.N.S. 1954, Ch. 215.
[30] For information, write Deputy Minister, Department of Mines, Halifax, Nova Scotia.

annual work requirement is 600 feet of lateral development work or its equivalent. Royalties are generally about 2 percent of the net value of production, but an annual royalty on profits may be substituted.

Petroleum

License

The basic unit for licenses is the reservation consisting of 18 mining tracts (each tract contains 1 square mile). One license may contain from one to 24 reservations. Except in offshore areas, no more than two licenses may be held by one person. The license has a term of 3 years and is renewable for a fourth and fifth year.

Lease

A licensee may obtain leases in a checkerboard pattern for a maximum of 50 percent of his licensed area. The balance of the licensed area becomes a Crown Reserve. The lease has a term of 20 years and is renewable for 20 years. The royalty ranges from 5 to 12-1/2 percent, depending upon rate of production.

## Prince Edward Island

The controlling statute is the Oil, Natural Gas and Minerals Act, 1957, Ch. 24, which is administered by the Department of Industry and Natural Resources.[31]

Licenses to prospect for minerals and leases to mine minerals other than petroleum are granted by the Lieutenant-Governor-in-Council on terms to be prescribed in regulations.[32]

Licenses to explore for oil and gas are issued for 1-year periods. The province has been divided into 43 license areas, ranging from 82,800 to 194,000 acres. The number of licenses which may be held by one person is not limited. Minimum annual expenditures per acre range from 5 cents in the first year to 25 cents in the fifth year. A licensee who has complied with the requirements of the law may obtain a lease on not more than 50 percent of his licensed area. A lease has a term of 21 years and is renewable for 10-year periods so long as petroleum is being produced. Royalties amount to 12-1/2 percent of production.

## Newfoundland and Labrador

The controlling statutes are the Crown Lands (Mines and Quarries) Act, 1961, and the Petroleum and Natural Gas Act, 1965. The Mines Branch of the Department of Mines, Agriculture and Resources[33] is responsible for administration.

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[31] For information, write Deputy Minister, Department of Industry and Natural Resources, Charlottetown, Prince Edward Island.
[32] Regulations Governing the Search For and Production of Oil and Gas, 1958.
[33] For information, write Director of Mineral Resources, Department of Mines, Agriculture and Resources, St. John's, Newfoundland.

## Mining

Mineral rights may be withdrawn from the operation of the act and granted to qualified companies by private agreements. In 1968, over 43 percent of the Province was held under such concession agreements.

Ordinarily, rights to minerals other than quarry materials, coal, and salt may be acquired by staking. Boring permits and leases are granted for coal and salt.

### Miner's Permit

A permit holder may stake an unlimited number of claims, each claim having an area of 40 acres; these must be recorded within 30 to 60 days after staking. The annual work requirement is 50 days' work for the first 3 years after recording. Payment in lieu of work may be made at the rate of $10 per day.

### Development License

A permit holder who has done the required work on his claim may obtain a development license, which gives the right to explore for and develop minerals, and to be granted a mining lease for the licensed area. A license may cover not more than 240 acres. The annual work requirement is 25 days' work for each 40 acres.

### Mining Lease

The term of a lease may not exceed 50 years. Exploration and development work must amount to $10 per acre during the first 2 years of the lease, and mining must begin within 2 years. A tax of 5 percent (20 percent in the case of iron ore mines) is levied on net income from mining operations.

## Petroleum

Petroleum rights include exploratory licenses to search throughout the Province, permits to prospect in specified areas, and leases to produce petroleum. No regulations governing the terms of these rights had been put into effect as of the end of December 1968.

# MEXICO

## Historical Background

The mining laws of Mexico are derived from laws of Spain, which had their roots in the Roman, Visigoth, and Arabic legal systems. Since 1821, when Mexico became independent, laws affecting mineral titles have been classed in three chronological groups:

1. Laws of the Spanish colonial type that were promulgated between 1822 and 1892 were characterized (with some exceptions) by Federal Government ownership of the mineral estate. Tenure of the mine was derived from the Government rather than from the surface owner and was dependent upon fulfilling the threefold requirements relating to discovery, filing a denouncement, and working the mineral deposit. During the early years of the period, the State claimed an aliquot part of the mineral production. Later the State levied a tax rather than seigniorage.

2. Between 1892 and 1917 laws of a liberal type prevailed. These were characterized by recognition of perpetual titles in the miner and were not conditioned upon production of minerals. For certain minerals the title in the surface owner was recognized.

3. The constitution of February 5, 1917, is the base of Mexico's modern mining and petroleum legislation. The Mining Law of 1930 under this constitution authorized three types of ordinary mining concessions in free ground: prospecting concessions, which required proof of the existence of a mineral deposit; exploitation concessions; and treatment plant concessions. The concession unit was a mining pertenencia which is 1 hectare in area. There was no extralateral right to pursue a vein beyond the vertical boundaries of the claim. The area and number of concessions that one individual could seek depended upon whether the desired area was in free ground (land that is not reserved or covered by a prior concession), or if it was within areas designated as national mining reserve.

In 1938 the properties of 17 petroleum production concessions were expropriated, and compensation was subsequently agreed upon. The decree of December 27, 1939, prohibits all oil and gas concessions and limits exploitation of petroleum resources to the Government.

## Controlling Statutes

Article 27 of the 1917 Constitution proclaims the National Government's ownership of minerals, but authorizes concessions for exploitation to individuals or qualified companies, conditioned upon working of the mineral deposits. The mineral and surface estates are severed; ownership of the surface does not include minerals occurring either on or beneath the surface.

The right to explore, mine, and process natural mineral substances is governed by the Law Regulating Article 27 of the Constitution in the matter of Exploitation and Treatment of Mineral Resources of 1961.[1]

Since the 1938 expropriations, the Mexican Government has operated the petroleum industry almost exclusively as a Government monopoly.

## Mining

Ownership of minerals is vested in the nation under article 27 of the Constitution. All mineral substances are subject to the 1961 law except petroleum and other hydrocarbons. Special laws apply to rock utilized for industrial and ornamental uses. The mining of uranium and similar minerals is under the control of the National Commission of Nuclear Energy.[2]

Only Mexicans and corporations organized under Mexican laws having a majority of capital owned by Mexicans have the right to obtain concessions. Article 27 of the 1917 Constitution provides that only Mexicans by birth or by naturalization and Mexican companies may acquire lands, water, or the right to exploit minerals, but that such rights may be granted to foreigners (except within 100 kilometers inland from the land borders and within 50 kilometers inland from the seacoast) who agree not to invoke the protection of their governments, under penalty of forfeiture. Prior to 1961 this article was not strictly administered. The 1961 law requires that at least 51 percent of the capital of a mining enterprise must be owned by Mexicans,[3] and reductions in direct taxes, such as production and export taxes, of 50 percent are available only to Mexicanized concessions.

Special concessions for exploitation of national mining reserves are granted only to companies in which Mexicans own at least 66 percent of the capital.[4] The national mining reserves constitute certain minerals and specified zones which have been removed from the provisions of the mining law governing ordinary concessions and are subject to special regulations. The Ministry of National Property may establish such reserves, subject to ratification by the President, when it is required by the needs of Government mining entities for industrial development or to insure future supplies for domestic needs.

The 1961 law authorizes exploration, development, and operation of mines by Government corporations, Government-participation corporations, and private persons and corporations. Government mining entities may contract with Mexicans or Mexican companies for performance of work.

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[1] Ley Reglamentaria del Articulo 27 Constitucional en Materia de Explotacion y Aprovechamiento de Recursos Minerales, published Diario Oficial, Feb. 6, 1961. The law was amended by an Executive Order published in Diario Oficial, Jan. 4, 1966. The Regulation of the Law was published in the Diario Oficial, Dec. 7, 1966. Translations of Mexican Mining Laws and Regulations are published by Traducciones, Apartado 52 Bis, Mexico 1, D.F.
[2] Decree published in Diario Oficial, Dec. 31, 1955.
[3] Articles 14, 15.
[4] Article 76.

## Administration

Administration of the mining law is the responsibility of the Ministry of National Property through the Bureau of Mines and Petroleum and regional mining agencies. The agencies maintain public records including applications for concessions, notice of discoveries, and matters concerning the status of land covered by concessions. For many important matters relating to organization and titles to concession, recording in the public Registry of Mining in Mexico City is mandatory.

Petroleum lands are assigned to a Government mining entity such as Petroleos Mexicanos, but are subject to mining concessions for minerals other than petroleum.

In 1934 the Mining Development Commission was created and given powers to carry out exploration, mining, and treatment activities. The 1961 law granted the Commission broader powers, including capacity to engage in mining and processing activities to the fullest extent. All iron ore deposits and most coal deposits have been placed under the jurisdiction of the Commission. The Commission receives a percentage of the net value of production in the national mining reserves by private parties.

The Advisory Board on Nonrenewable Natural Resources has power to make recommendations concerning nonrenewable resources and minerals to be incorporated into the national mining reserves, to carry out geological studies and exploration, and to advise as to technical and legal matters which affect national mining policy.

## Ordinary Concessions

Mineral rights in free ground are generally acquired by obtaining a concession which grants the right of exploitation and treatment. Ownership of a concession does not include surface ownership; however, mining takes precedence over other uses of land.

Mining rights are initiated by making an application for a concession at the mining agency having jurisdiction over the area where the property is located. Discovery of minerals is not a prerequisite. Surveying, mapping, and monumenting requirements must be met before the Ministry of National Property in Mexico City will issue a "title."

Applications for concessions are limited to a maximum of eight different minerals, but a concessionaire has a right to include any additional minerals he discovers in his title, provided that they are not included in the national mining reserves. Limitations on total area which may be exploited by one concessionaire range from 1,000 to 8,000 hectares, depending upon the group of minerals involved.

The law does not expressly create exploration concessions. However, during the exploration stage (but for no longer than 5 years), the lands covered by concessions are computed as being only 33 percent of the actual

surface area. Therefore, limitations on total area during exploration range from 3,000 to 24,000 hectares, depending upon the group of minerals involved. Progress of exploration work must be reported annually. At the end of 5 years, the area of the concession must be limited to the statutory maximum.[5]

Under another procedure, mining companies may apply for exploration concessions on areas exceeding in size those specified above for the purposes of developing reserves of industrial minerals. To qualify for this right, which is called "industrial mining reserves," a mining company must have facilities to produce industrial minerals and must have executed long-term contracts committing at least 50 percent of its production to supply needs within Mexico.

Concessions are issued for 25 years and may be extended for an indefinite time if minerals are being produced. Concessions may be assigned or leased provided that the provisions of the Regulations are complied with. A concessionaire must satisfy minimum annual work requirements, including a minimum annual expenditure of 3,000 pesos (1 peso = US$0.08) per concession. There is an additional obligation based upon surface area and class of minerals covered by the title.

The law specifies that a concession may be terminated for the following causes: failure to pay surface tax, failure to carry out work requirements, and failure to observe the requirements concerning Mexican participation.

### Processing Plant Concessions

There are two types of processing plants, public and private. A mining concessionaire must obtain a processing plant concession unless its plant's capacity is less than 100 tons per day. Concessions are issued by a commission composed of representatives of the Ministries of National Property and Industry and Commerce. A processing plant concession is issued for 25 years, and its terms are generally the same as those of a mining concession.

### Concessions in National Mining Reserves

Special concessions in the national mining reserves are issued only to Mexicans or Mexican companies with 66 percent Mexican ownership. Concessions are awarded by bidding upon the petition of an interested party. Applications must set forth a work program, proposed investment and method of financing, and technical capability. Except in the event that a better bid is submitted, the party which has petitioned for the bidding will be granted the concession.

The concessionaire is subject to the minimum requirements of the 1961 law and regulations, and to special terms established by the Ministry. Private concessionaires are required to pay a percentage of the value of the mineral production to the Mining Development Commission and to the Advisory Board on Nonrenewable and Natural Resources.

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[5] Article 27, Regulation 143.

## Fiscal Provisions[6]

Mexico imposes simultaneously a production, export, and income tax. Other taxes imposed on the mining industry include surface tax, municipal export tax, state property tax, transportation tax, stamp tax, dividend tax, import duties, education tax, and a special sales tax on gold and silver.

Concessionaires which have Mexicanized are entitled to a reduction of 50 percent of the Federal Government's share of the export and production taxes. Partial relief from the production tax is available in the case of new mines and mines reactivated after a shutdown.

Subsidies, which constitute an automatic reduction in the Federal Government's share of export and production taxes, are available for small and medium-sized mining companies which have a majority of Mexican capital.[7]

The Mining Tax Law provides for special tax agreements for specified purposes, which are negotiated with the Ministry of Finance.

## Petroleum

Petroleum exploration and development were originally governed by the general mining laws of 1884, 1892, and 1909. Article 27 of the Constitution of 1917 declared that ownership of petroleum resources was vested in the Nation, and led to enactment of the Petroleum Law of December 26, 1925. In 1938 the properties of 17 companies were expropriated.

Granting concessions for petroleum was prohibited in 1939[8] following the establishment of Petroleos Mexicanos (PEMEX), a Government-owned corporation.[9] The present law governing exploration and development of petroleum resources was enacted in 1958[10] and is administered by the Ministry of National Property.

PEMEX conducts all activities of the petroleum industry under article 4 of the 1958 law from exploration to the sale and distribution of petroleum products. It administers lands assigned to it by the Federal Government, and pays royalties ranging from 10 to 35 percent. PEMEX may enter into contract with individuals or corporations for services, but only for cash compensation. In no case may services be paid for with a percentage of production.

The petroleum industry is of public utility and is under exclusive Federal jurisdiction. Only the Federal Government may seek to regulate it or to impose taxes on it.

The Federal Executive is authorized to establish petroleum reserve zones in order to guarantee the future supply of the Nation.

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[6] Law of Mining Taxes and Development, Diario Oficial, Dec. 31, 1955.
[7] Ruling 101-744, Diario Oficial, May 22, 1963; Mar. 14, 1966; Aug. 20, 1966.
[8] Amendment to Article 27 of the Constitution on Dec. 27, 1939; Nueva Ley Reglamentaria del Articulo 27 Constitucional, en el Rame de Petroleo, Diario Oficial, June 18, 1941.
[9] Decree, Diario Oficial, July 20, 1938.
[10] Ley Reglamentaria del Articulo 27 Constitucional en el Ramo del Petroleo, Diario Oficial, Nov. 29, 1958, and Dec. 31, 1958; Reglamento de la Ley, Diario Oficial, Aug. 25, 1959, and Sept. 24, 1959.

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## UNITED STATES

### Controlling Laws

The acquisition of mineral rights in the United States is governed by either Federal or State law, depending upon whether the mineral property sought is owned by the Federal Government, a State, or an individual.

Federal lands are placed by the Constitution under the control of Congress, which over the years has enacted many laws pertaining to the mineral development of the public domain. The most important of these laws are:

1. The Mineral Location Law of 1872,[1] governing lode and placer claims for hard minerals on the public domain;

2. Leasing Regulations under the Reorganization Act and other acts,[2] governing hard minerals on Federal acquired lands;

3. the Mineral Leasing Act of 1920, as amended,[3] governing coal, phosphate, sodium, potassium, oil, oil shale, gas, asphalt, bitumen, and bituminous rock;

4. the Outer Continental Shelf Lands Act of 1953,[4] governing all minerals on the Continental Shelf beyond territorial waters;

5. the Materials Disposal Act of 1947,[5] as amended by the Multiple Surface Resources Act of 1955,[6] governing commonly occurring surface minerals.

State-owned lands are subject to mineral development laws enacted by the State legislatures. The States have followed various patterns in their mineral laws, but for the most part these laws are modeled after Federal legislation.

Privately owned lands are subject to the law of the State in which they are found, including the law governing property titles, sales and conveyances, leases, licenses, and contracts. Private rights are subject to general Federal and State legislation pertaining to such matters as conservation, air and water pollution control, taxation, safety, health, subsidence control, zoning, and other matters within the constitutional powers of the two governments.

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[1] 17 Stat. 91, 30 U.S.C. secs. 22, 23, 26 (1964); 43 C.F.R. sec. 3400 (1967).

[2] The Reorganization Plan #3 of 1946, 5 U.S.C.A. appendix at 188 (1967), and 43 C.F.R. secs. 3220-27 (1967).

[3] 41 Stat. 437, as amended, 30 U.S.C. secs. 181 et seq. (1964). See also Acquired Land Mineral Leasing Act of 1947, 61 Stat. 913, 30 U.S.C. secs. 351 et seq. (1964).

[4] 67 Stat. 462, 43 U.S.C. secs. 1331-43 (1964).

[5] 61 Stat. 681, as amended, 30 U.S.C. secs. 601-604 (1964).

[6] Sometimes designated the Common Varieties Act of 1955, this law, as amended, prohibits future location under the mining laws of common varieties of minerals including sand, stone, gravel, pumice, pumicite, cinders, and petrified wood, 69 Stat. 367 (1955), 30 U.S.C. secs. 601-604, 611 (1964).

## Federal Lands

The administration of all Federal mineral lands is the responsibility of the Bureau of Land Management in the Department of the Interior. Other agencies within this Department, notably the Office of Oil and Gas, Office of Minerals and Solid Fuels, Bureau of Mines, and Geological Survey, have important responsibilities for programs for development, conservation, and utilization of mineral resources.

In 1968 federally owned lands open to mineral location under the law of 1872 amounted to approximately 31 percent of the total area of the United States, mostly in the States west of the Mississippi River and in Alaska.[7] Development of minerals in "acquired" Federal lands is governed by a leasing system described in part B.[8] Minerals in insular possessions of the United States are not regulated by the general Federal laws, but by acts of the local legislatures or by special Federal statutes.

### A. Mining: Mineral Location Law of 1872

The first general U.S. mining act was the act of 1866, which announced three important principles: (1) That all mineral lands of the public domain should be free and open to exploration and occupation, (2) that rights that had been acquired in the public domain under local rules should be recognized and confirmed, and (3) that title to mineral deposits might be obtained when certain statutory procedures had been complied with.

Experience gained under the act of 1866 led to certain changes which were incorporated in the Mineral Location Law of 1872. This law authorized granting of full legal title to lode and placer mining claims and remains the basic law governing acquisition and maintenance of title to mining claims for metalliferous minerals (including uranium) on the public domain. Title is evidenced by a patent and includes both surface and subsurface rights. The act continued the basic policy of free and open exploration and mining on the public domain. Local and State laws are recognized only to the extent that they do not conflict with the provisions of the Federal law.

#### Qualifications of Applicants

Congress proclaimed in the act of 1872 that only "citizens of the United States, and those who have declared their intention to become such" may acquire rights to public mineral lands. Domestic corporations are considered citizens. Although an alien cannot acquire title by patent or location valid against the Federal Government, his location, inheritance, or purchase of an unpatented claim is not subject to question by persons other than the Federal Government.

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[7] Federal lands open to mineral location include most of the "public domain," and (with some exceptions) national forests and certain other reserved lands. See 43 C.F.R. sec. 3400-1 (6).

[8] Acquired lands, which total about 52 million acres, include lands that have been obtained through purchase, gift, or other manner, but do not include cession from the original States of the Union or from other sovereign nations. The acquired lands subject to the regulations described in part B are listed in 43 C.F.R. sec. 3220. 0-6.

Requirements of a Valid Location

A discovery is the prime requisite for the establishment of a valid location. The discovery requirement is satisfied "where minerals have been found and the evidence is of such a character that a person of ordinary prudence would be justified in the further expenditure of his labor and means, with a reasonable prospect of success, in developing a valuable mine."[9] In recent years, this prudent-man test of a discovery has been supplemented by a marketability test requiring that the mineral deposit be marketable at a profit at the time of discovery, at least in the case of nonmetallic minerals of wide occurrence.[10]

The law authorizes two types of claims. Lode claims may be located on veins or lodes where the mineral is in place. Placer claims may be located on other forms of mineral deposits.

Lode Claims.--A lode location may not exceed 1,500 feet in length along the vein or lode (sidelines), nor more than 300 feet on each side of the vein (endlines) at the surface. Surface endlines must be parallel. State laws may limit the width of claims to not less than 25 feet on each side of the vein, and may require additional steps to perfect a location, such as the sinking of a discovery shaft. A valid location may be made only on the top or apex of the vein. If the claim is properly located with respect to the apex, the locator is granted an extralateral right to follow the vein downward on its dip through the sidelines of his claim and under adjoining property. If the claim is improperly located, the location is invalid against a subsequent locator who properly includes the apex in his claim. The "apex rule" has produced much litigation and uncertainty in mining rights.

Placer Claims.--A placer location may include no more than 20 acres for each individual claimant or 160 acres for associations of claimants, and should conform as nearly as practicable to the surveyed public subdivisions. The "apex rule" does not apply to placer claims; these have no extralateral rights. Boundaries extend vertically downward from the surface lines.

After discovery, the boundaries of the location must be marked on the surface. There is no general requirement that lode or placer claims be recorded with a Federal agency, although recent laws[11] require the recording of certain claims with the local land office; many States make it mandatory to record mining locations in the county recorder's office.

The number of mining claims that may be located by an individual, corporation, or association is unlimited, provided each claim contains a discovery.

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[9] Castle v. Womble, 19 L.D. 455 (1894), approved in Chrisman v. Miller, 197 U.S. 313, 322 (1905).
[10] U.S. v. Coleman, 390 U.S. 599.
[11] 69 Stat. 679 (1955), 30 U.S.C. secs. 541-41(i) (1964) (location for coal); 69 Stat. 681 (1955), 30 U.S.C. secs. 621-25 (1964) (lands withdrawn for power development).

Rights and Obligations Under Unpatented Locations

Once a valid discovery and location have been made, the locator acquires a vested interest in the mining claim and may exploit the minerals. Many unpatented mining claims have been worked commercially for years. Although title remains in the Federal Government, an unpatented mining location gives an exclusive right of possession for mining purposes. Uses of surface resources on unpatented claims located after July 1955 are limited to uses incident to prospecting, mining, or processing operations.[12]

To maintain a claim the 1872 act requires that at least $100 worth of development work be done each year, but there is no Federal recording requirement. Most States have laws concerned with the proof of performance of assessment work. Types of work which will satisfy the annual requirement were extended to include geological, geophysical, and geochemical surveys in 1958.[13] Failure to perform the work allows a relocation of the claim by other persons.

Proceedings To Acquire Patent

To obtain title to land covered by a location, the locator must apply to the Bureau of Land Management for a patent. Steps that must be followed in patent application proceedings include (a) posting notices on the claim, in the Land Office register, and in newspapers; (b) proof of citizenship; (c) an official land survey; (d) proof of mineral character of the location; (e) proof of $500 worth of improvements; and (f) presentation of an abstract of title. Proceedings are begun in the local Land Office of the Bureau. Should an adverse claim or right by another claimant arise, the mining laws provide for contest proceedings in any Federal or State court of competent jurisdiction to determine which of the claimants has the superior right of possession. In such a case the Land Office suspends patent proceedings until the dispute is settled by the Court.

After the above procedures have been completed, the applicant pays a purchase price of $5 per acre for lode claims or $2.50 per acre for placer claims and receives a patent. The patent gives title not only to the mineral estate, but also to the surface and all surface resources.

No royalties of any kind are levied on the production of any patented or unpatented mining claims under the 1872 act.

B. Mining: Leasing Regulations

The mineral location law described in part A has not been extended to Federal "acquired lands." On these, development of minerals other than oil, gas, oil shale, coal, phosphate, potassium, sodium, and sulfur is governed by regulations authorizing issuance of prospecting permits and competitive leases. The decision whether to proceed by permit or by competitive leasing is made by the U.S. Geological Survey. The Bureau of Land Management is responsible for administering the regulations.

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[12] 69 Stat. 368 (1955), 30 U.S.C. sec. 612(a) (1964). Unpatented claims located before July 1955 may be subjected to the same surface restrictions through an in rem procedure. 69 Stat. 309 (1955), as amended, 30 U.S.C. sec. 613 (1964).

[13] 72 Stat. 1701 (1958), 30 U.S.C. sec. 28 (1964).

Prospecting Permits

No applicant may hold more than 20,480 acres under permit and lease in any one State, nor more than 10,240 under lease. Under certain circumstances the Secretary of the Interior may authorize a lessee to hold an additional 10,240 acres under lease.

Prospecting permits are issued to the first qualified applicant for a period of 2 years and grant the exclusive right to prospect on the specified lands. A permit may not include more than 2,560 acres, which must be entirely within an area of 6 miles square or an area not exceeding six surveyed sections in length or width.

The holder of a permit must pan an annual surface rental of 25 cents per acre but not less than $20 per year.

A permit may be extended for one additional term of 2 years upon a showing of diligent prospecting activities during the primary term. The holder is liable for 12-1/2 percent royalty on minerals mined during the period prior to issuance of a lease.

Preference Right Lease

Upon discovery of any valuable deposit of minerals the holder of a permit is entitled to a preference right lease, subject to the acreage limitations. The terms and conditions of a lease, including royalty rates, are established on an individual case basis.

The term of a lease may not exceed 20 years and is determined upon the advice of the agency having jurisdiction over the land and the U.S. Geological Survey. A right of renewal is granted for consecutive periods not exceeding 10 years each, upon such terms and conditions as may be prescribed by the Secretary of the Interior.

Competitive Leasing

Except as described above, leases for lands containing valuable mineral deposits are issued to the qualified person who offers the highest bonus by competitive bidding. Following the filing of an application for a lease through competitive bidding, notice of the offer of the mineral deposits for lease is published.

Leasing units may not exceed 2,560 acres. The lease contains operating and producing requirements and provisions dealing with rentals or minimum royalties. The Code of Federal Regulations has provisions concerning bonds, operating contracts, relinquishment, termination, transfers, overriding royalties, and fractional and future interests.

## C. Minerals Covered by the Mineral Leasing Act

The Mineral Leasing Act of 1920 covers coal, phosphate, sodium, potassium, oil, oil shale, gas, asphalt, bitumen, and bituminous rock, and is the basic law governing acquisition of those nonmetallic minerals located on the public domain. Unlike the Mineral Location Law, which provides for the granting of

title to mineral deposits on Federal lands without payment of royalties, the Mineral Leasing Act provides that title is to remain in the United States, subject to lease under certain specified conditions.

Under the amended Leasing Act the requirements for obtaining a leasehold interest in oil and gas on the public domain depend on whether the land sought lies within or without the known geologic structure of a producing oil or gas field. Lands lying within the geologic structure of a producing field are subject to lease only by competitive bidding; all other lands may be prospected under noncompetitive, wildcat leases. Only citizens of the United States, associations of such citizens, or corporations organized under Federal, State, or territorial laws are eligible to hold a lease. The following paragraphs summarize the two types of Federal leasing.

## Noncompetitive Leases

The acquisition of a noncompetitive lease, which is issued to the first qualified applicant, is initiated by filing an application with the Bureau of Land Management. A lease grants the exclusive right to conduct explorations on a specified tract for a period of 10 years and as long after that as oil or gas is produced in paying quantities. A $10 filing fee and the payment of the first year's rental of $0.50 per acre must accompany each application. Special rentals apply to cooperative or unit plans. A lease may not exceed 2,560 acres, but the act permits a person, association, or corporation to hold any number of oil or gas leases, subject to a maximum acreage limitation of 246,080 acres in any one State.[14] A royalty of 12-1/2 percent of production must be paid to the Federal Government. Rights under a lease may be assigned in whole or in part by the lessee, but only with the approval of the Secretary of the Interior, who requires the same qualifications of the assignee as an original applicant. The lessee may negotiate an "operating agreement" with a third party to develop the oil and gas potential of the lands, subject to the approval of the Secretary. The lessee in this instance normally reserves to himself an overriding royalty, which is limited, in the case of oil, to no more than 5 percent when production of the well does not exceed 15 barrels of oil per day. An operator may engage in large-scale geophysical explorations by obtaining options from lessees or owners in the area.

## Competitive Leases

Leases for lands lying within the known geologic structure of a producing oil and gas field may be issued under the statute only by competitive bidding. Bids are invited, and the highest qualified bidder (cash bonus) must agree to pay the royalty rate, specified in the notice inviting bids, on all oil and gas produced. Royalties payable to the United States range from 12-1/2 to 25 percent for oil and 12-1/2 to 16-2/3 percent for gas. The annual rental is $2 per acre. Leases are issued for 5 years, in units not exceeding 640 acres, and continue so long as petroleum is produced in commercial quantities.

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[14]Alaska is divided into two leasing districts, and the limitation for each district is 300,000 acres.

Lessees may agree among themselves to develop and operate a common oil-field, under a cooperative or unit plan of development for the purpose of conserving natural resources, subject to the agreement of the Secretary. No oil or gas lease on producing land may be canceled except by judicial proceedings. Although the lessee acquires ownership of the mineral production, his rights to the surface area are specifically limited to uses necessary for his petroleum operation. The United States reserves the right to dispose of the remaining surface area by sale, lease, or other manner. At the expiration of the lease, the lessee must restore the surface of the lands embraced therein, or he may be required to pay damages for crops or timber destroyed or streams polluted.

All leases include provisions requiring the exercise of reasonable diligence, skill, and care in the operation of the property, and for the prevention of waste; the lessee is obligated to keep records, including a daily drilling account, logs, and reports of well surveys and tests of subsurface investigations. Production records are required as well, showing both quantity and quality of oil and gas produced.

## D. Offshore Minerals

The competitive leasing principle was extended to the Continental Shelf beyond the limits of State jurisdiction (generally 3 miles seaward from the coast) by Congress in 1953. The Secretary of the Interior was authorized to prescribe such rules and regulations as he believes advisable with respect to leasing the oil and gas and other minerals of the Outer Continental Shelf.[15] Oil and gas leases are granted by competitive bidding on the basis of a cash bonus and a royalty fixed by the Secretary at not less than 12-1/2 percent of production. Oil and gas leases have a term of 5 years and are renewable as long as petroleum is produced. Sulfur leases are issued for 10 years and are subject to a royalty of 5 percent. The act permits the Secretary, at his discretion, to fix the cash bonus and allow competitive bidding on the amount of royalty, but only competitive bidding on the cash bonus with a fixed royalty has been used.

## E. Multiple Use Legislation

Prior to 1954 conflicts arose on Federal lands between claimants under the Mineral Location Law of 1872 and the Mineral Leasing Act of 1920, which led to the enactment of the Multiple Mineral Development Act of 1954.[16] The act permits joint use of the same tracts of public lands for development of minerals covered by the location and leasing laws. Its immediate effect was to open some 60 million acres of public lands, then under oil and gas lease, to location for uranium and other minerals. It also stimulated oil and gas development by authorizing operations for leasable minerals on lands open to location under the 1872 act, and by establishing a means for determining the validity of any rights claimed for Leasing Act minerals under patented mining claims located prior to the effective date of the act.

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[15] See 43 C.F.R. sec. 3380 (1967).
[16] 68 Stat. 708, 30 U.S.C. sec. 521 et seq. (1964).

Disputes also arose concerning rights to use surface resources including commonly occurring surface minerals, timber, and vegetative materials. Mining claims located for nonmining purposes were a growing problem. Congress attempted to settle these conflicts by enacting the Multiple Surface Use Act of 1955.[17] This act prohibited location of mining claims for common varieties of mineral materials under the Mineral Location Law of 1872.[18] Holders of mining claims located after the date of the act are prohibited from using the land for purposes other than prospecting, mining, processing, and incidental operations until their claims are patented. During this period the claim is subject to the right of the Secretary of the Interior to manage and dispose of common varieties and nonmineral surface materials.

With respect to unpatented mining claims already in existence on the date of the 1955 act, the Federal agency which has responsibility for administering surface resources may initiate a proceeding for determination of surface rights.[19] The act requires publication of notice and a title search of the county records for unpatented mining claims. Holders of unpatented claims may file a verified statement to preserve their rights to all surface resources of the claim. Mining claimants who fail to file such a statement of a conflicting interest within 150 days after notice are deemed to have waived their rights to the surface resources.

A thorough examination of Federal mineral laws by the Public Land Law Review Commission[20] was submitted to the President and the Congress in early 1970.

## State Lands

The States have come into ownership of lands by various means. Upon admission to the Union, the original 13 and a number of other States had sovereign power over public lands within their borders. The Federal Government has granted public domain to the States for various purposes--school land grants, swamp land grants, and other special grants. The Federal Government often reserved mineral rights in lands of known mineral value, but otherwise the States acquired all rights to the lands received under these grants.

All but about four States have mineral leasing laws for State-owned mineral lands and minerals reserved in sales of land to private persons. Petroleum is usually subject to special provisions, as are minerals of local importance. Several coastal States, having jurisdiction over seabed and subsoil minerals to a distance generally of 3 marine miles from their coasts,[21] have enacted special offshore mineral leasing laws. These laws are designed primarily for petroleum operations.

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[17] 69 Stat. 367, 30 U.S.C. secs. 601-615 (1964).
[18] See footnote 5.
[19] 30 U.S.C. sec. 613 (1964).
[20] 78 Stat. 983, 43 U.S.C.A. secs. 1391-1400, as amended by P.L. 90-213 of Dec. 18, 1967.
[21] The Submerged Lands Act of 1953, 43 U.S.C. secs. 1301-15 (1964). Texas and Florida have jurisdiction in the Gulf of Mexico to a distance of 9 marine miles, based upon the Supreme Court's view of their historic boundaries.

Reference must be made to the statutes and cases of the 50 States to learn the law and procedures applicable to mineral development. Each State has an agency responsible for State land management activities, including mineral resource development.

The practice under the Mineral Location Law of 1872 of opening lands to exploration and giving the discoverer a right to locate claims has not been widely adopted. In Alaska, Arizona, Colorado, Idaho, Maine, New Hampshire, Oregon, and Texas, the law provides some form of location as a step in the process of obtaining a mineral lease. Only in Texas does locating a claim lead to a patent. The distinction between lode and placer claims and recognition of extralateral rights are seldom found.

A prospecting permit of limited duration is often required in order to prospect for minerals. In some States this permit may be exclusive and give the permittee who discovers minerals a priority to a lease. In many States, leases may be issued without competitive bidding according to priority of application; in others, the State law may require advertisement and competitive bidding. Generally, land descriptions must be by legal subdivisions only. Leases for hard minerals are usually for an initial term up to 20 years, with a renewal right. Oil and gas leases are usually for a term of 5 years or more, and as long thereafter as commercial production continues. State petroleum leasing laws generally distinguish between leases within known producing geological structures, which are issued by competitive bidding, and leases on lands not located within such structures, which are issued upon application at rents and royalties specified by law.

## Private Lands

For those lands which are not owned by Federal or State governments, the prospective mineral developer must negotiate with the private owner, which may be an individual, association, or corporation. The United States is one of the few countries in which private persons may hold title in fee simple to mineral resources.

The transfer of mineral rights and titles between private persons is governed in most matters by the State laws concerning real property and contracts. Special legislation dealing with the transfer of mineral rights is seldom found. However, in the major mineral producing States, there are often special provisions concerning grubstakes and other employment contracts, miners' liens, encumbrances, etc.

Persons seeking to carry out exploration work will often negotiate exploration contracts or option agreements with private landowners before committing themselves to a formal lease or sale. These agreements vary in the rights granted to the prospector and the obligations of the prospector to carry out active exploration and development work.

Rights to mine minerals on private lands are acquired through either a lease or a sale. Lease agreements take a wide variety of forms, depending largely on the stage to which prospecting and exploration has progressed, the type of mineral, the techniques to be utilized, the bargaining position of the

parties, and regional practice with respect to the mineral in question. In the case of petroleum, and to a lesser extent coal, a large body of case law has grown up concerning the legal effect of standard clauses in leases. For other minerals, there is little uniformity of practice. The form of a lease is often patterned on contemporary practice in the field of oil and gas leases. Generally, a lease will provide for an initial term, a renewal right so long as commercial production is maintained, a rental in lieu of royalties or a surface rental during the term of the lease, a royalty payable to the landowner computed on the basis of the quantity of ore extracted, and covenants to assure reasonable development activity.

## Special Problems of Tenure Relating to Oil and Gas

The States may regulate spacing, drilling, and operation of oil wells to prevent waste and protect the correlative rights of the common owners of an oil or gas pool on private, State, and Federal lands within their borders. The major producing States, except California, accomplish these objectives through complicated systems of public regulation.

Each State has its own system, and the systems are not uniform. Generally, when demand exceeds production capacity, well production is limited to the maximum efficient rate of production (MER) to prevent premature exhaustion of reservoir pressures. MER's are based upon the geological characteristics of a reservoir, including porosity, thickness, and energy source.

When production capacity exceeds demand, production control is accomplished by the setting of a statewide total, based on estimated demand during a future period, and assigning parts of the statewide total to individual producers as production quotas. These quotas are determined by a depth-acreage formula. Exemptions to this proration process are usually available for "marginal" wells (which are permitted to produce at capacity), "discovery" wells, and secondary recovery projects. Several States provide procedures for voluntary and compulsory unitization of oilfields.

The Connally "Hot Oil" Act,[22] a Federal statute, supplements the State regulatory systems by prohibiting interstate transportation of oil produced in violation of the law of its State of origin. The States are also aided in their regulatory efforts by the U.S. Bureau of Mines periodic forecasts of supply and demand. The States are not obligated to follow these forecasts, but the forecasts have proved accurate and useful in stabilizing production at levels that prevent waste.

Through the Interstate Oil Compact, 29 States voluntarily act together to conserve their petroleum resources and coordinate their petroleum regulations. Four other States participate as associate members.

Oil imports are an important factor in the supply and demand calculations, which are necessary for administration of the proration systems of most States. Again, Federal law assists the States. The President has the power to regulate

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[22] 15 U.S.C. sec. 715 (1964).

imports in industries affecting the national security.[23] In 1959, the President made the Department of the Interior responsible for establishing import limitations to assure that domestic industry could meet all requirements of national security.[24] An elaborate system of licensing has developed, including an Appeals Board.

The Federal Government plays a greater role in the regulation of the natural gas industry than the petroleum industry. Natural gas pipelines operating in interstate commerce are regulated as to field price and wholesale prices and services by the Federal Power Commission under the Natural Gas Act of 1938.[25] New pipelines and extensions and abandonment of existing pipelines have to be certified by the Commission on the basis of their gas supply, markets, project revenues, and costs.

To the extent that mineral tenure is concerned, oil and gas occupy a unique position. The mineral estate in private lands is owned by the surface owner and his lessee, but the right to develop and produce oil and gas can be, and in most States is, regulated by the State to a degree far exceeding its control of the use of any other kind of private property, and gas production and transmission are subject to further Federal controls.

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[23] 19 U.S.C. sec. 1862(c), formerly 19 U.S.C. sec. 1352(a).
[24] Presidential Proclamation 3279 (Mar. 12, 1959), 24 Fed. Reg. 1781 (1959).
[25] 15 U.S.C. secs. 717-17w (1964).

# BARBADOS

## Controlling Statutes

Barbados became independent on November 30, 1966, and is a member of the British Commonwealth.

Petroleum operations are governed by the Petroleum (Winning Operations) Act, 1950, as amended, and the Petroleum Drilling and Production Regulations, 1950, as amended.[1] These laws apply to both onshore and offshore petroleum operations.

Other mineral operations are subject to the Mines Regulation Act of 1899, No. 2, which prescribes working conditions, and Quarries Act of 1951, No. 9, as amended.[2]

### Petroleum

The Petroleum Act of 1950 revoked, with full compensation, the concessions held by the British Union Oil Co. All petroleum resources are vested in the Governor-in-Executive Committee, who has the power to grant licenses and leases to such persons as he thinks fit and upon such terms and conditions as he may determine.

The holder of a license or lease may apply for "ancillary rights" to facilitate the proper and efficient exploration for and production of petroleum. These rights (relating to rights of way, occupation, and use of water) are granted by the Ancillary Rights Commission, and may be granted either at the time when a license or lease is granted, or at any subsequent time, subject to payment of compensation to surface owners.

The Regulations require that a drilling license be issued before a drilling operation may start and that a security deposit of $5,000 be paid to guarantee proper control, completion, or abandonment. The Regulations have provisions relating to spacing areas, well logs, casings, equipment, water, prevention of waste, and storage of petroleum. Drilling operations may not be suspended for more than 3 months without approval.

Royalties are payable at rates determined by the Government and the holder. The owners of land situated in a pooling area are entitled to petroleum quota payments, based upon royalties paid on production from the area.

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[1] The most recent amendment to the Petroleum Act, 1950 is the Petroleum Act, 1950 (Amendment) Act, 1968. See also the Petroleum and Natural Gas Conservation Regulations, 1950.

[2] For information, write Secretary, Ministry of Trade and Labour, Bridgetown, Barbados.

Petroleum operations are subject to a 50-percent tax based on net (chargeable) profits.[3] In computing chargeable profits, an incentive allowance is deducted, amounting to 10 percent of the gross income, but not to exceed 50 percent of gross income after making all deductions and other allowances.

A depletion allowance is provided with respect to qualifying capital expenditure. It may amount to not more than 20 percent of such capital expenditure incurred prior to the effective data of the concession, and not more than 10 percent of such expenditure subsequent to the effective date. Qualifying capital expenditures, on which the depletion allowance might be based, are reduced by the amount of any incentive allowance made.

[3]The Petroleum Winning Operations Taxation Act, 1958.

# BRITISH HONDURAS

## Controlling Statutes

The basic mining law is the Minerals Ordinance Chapter 125 of the Laws of British Honduras, Revised Edition 1958, as amended by subsequent Ordinances (No. 19 of 1962 and No. 40 of 1963) and Statutory Instrument No. 17 of 1964. Regulations made under this Ordinance are contained in Statutory Instruments No. 3 of 1932 and No. 65 of 1952.[1]

The law relating to petroleum is the Petroleum (Production) Ordinance Chapter 126 of the Laws of British Honduras, Revised Edition 1958, which is based on Ordinance No. 17 of 1937, and the Oil Mining Regulations (Statutory Instrument No. 56) of 1949, as amended.

## Mining

The mining law vests control of all minerals in the colony in the Crown, except those rights acquired by grants prior to the Ordinance. With the exception of mineral oils, chapter 125 governs the right to prospect and mine for the following: (1) All precious minerals found anywhere in the colony, (2) coal, except lands granted in fee simple by the Crown or acquired before July 1, 1886, and (3) all other minerals except those from lands granted in fee simple by the Crown, or in which titles adverse to the Crown were acquired on a prior date.

At the discretion of the Minister areas may be closed for the prospecting and mining of specified minerals. Additionally, no prospecting or mining may be conducted (1) on land devoted to public uses, (2) on land occupied by a town, village, Government building, public road, or tramway, (3) on land under cultivation without the consent of the owner or occupier, and (4) on private land or land subject to a Crown lease without the consent of the owner or occupier.

With the exception of persons associated with the Government of British Honduras in either a civilian or military capacity, prospecting and mining rights may be granted by the Minister to any person, individual or corporate. Individuals not resident in British Honduras and foreign corporations must be represented by an attorney resident in the colony having full power of attorney with respect to all matters relating to the lease, right, or license.

### Prospecting Right

Prospecting may be conducted only under a prospecting right or an exclusive prospecting license. A prospecting right, valid for 1 year, may be granted by the Minister to any person over 18 years of age who is able to read and understand the Ordinance and who has not been guilty of any previous offenses under the Ordinance. The right is not transferable and entitles the holder to enter upon and prospect any land that is not reserved or subject to

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[1] For information, write Permanent Secretary, Ministry of Natural Resources and Trade, Belize City, British Honduras.

an exclusive prospecting license, a mining right, or a mining lease. For the purposes of prospecting, the holder is entitled to sink shafts and wells and to dig trenches. A prospector intending to prospect on private land, or on land occupied under a Crown lease, or under a location ticket or permit to occupy must give notice of his intention to the surface owner or occupier of such land; and if required by the owner or occupier, he must give security by depositing with the Government such sums as the Minister may direct for the payment of compensation for disturbance to surface rights.

## Exclusive Prospecting License

Exclusive prospecting licenses to an area not exceeding 16 square miles (1 square mile for precious minerals) may be granted by the Minister to any person who has prospected the area for which the license is sought. The applicant must satisfy the Minister that he has enough capital to insure proper prospecting of the area and payment of any required compensation to surface owners. An exclusive prospecting license is granted for a period of 1 year, and may be renewed at the discretion of the Minister for a maximum of 3 years for an alluvial working and 6 years for a lode working. The Ordinance gives the Governor absolute discretion to grant a special exclusive prospection license for a longer period and larger area, which may be renewed three times for 1 year each. The holder of an exclusive prospecting license has the sole right to prospect upon the lands within the area described in his prospecting license, subject to the payment of compensation for the disturbance of surface rights. The major obligation of a holder under an exclusive prospecting license is to adequately and continuously carry out bona fide prospecting operations.

Reserve minerals obtained in the course of prospecting under a prospecting right or an exclusive prospecting right are the property of the Crown and may only be removed from the land and disposed of by the holder with the consent of the Government Inspector of Mines.

Exploitation of mines in British Honduras, except on private lands held in fee simple, may be conducted only under a mining right or mining lease.

## Mining Right

A mining right may be granted by the Minister to the holder of a prospecting right or exclusive prospecting license. The mining right confers upon the holder the right to enter upon the lands specified and the exclusive right to mine the alluvial-reserved minerals specified in the right, subject to payment of such royalties, surface rents, or other consideration prescribed by the Minister. Mining operations must be carried on continuously, and the holder is under the obligation to furnish the Government Inspector of Mines with technical reports of his operations.

Mining rights are valid for 1 year and may be renewed each year. The holder of a mining right may be required by the Minister, under penalty of losing the mining right, to apply for a mining lease if it appears that the mineral-bearing qualities of the land are extensive.

## Mining Lease

A mining lease may be granted to the holder of a prospecting right or to the holder of an exclusive prospecting license who has conducted authentic prospecting operations on the area applied for. The holder of a mining right may be granted a mining lease in respect to any portion of the area of his right. A showing of enough working capital to insure proper development and working of the area may be required. Leases are granted for a period not to exceed 21 years and may be renewed an additional 21 years upon the terms then in force.

The following types of mining leases may be obtained in British Honduras:

Class A--Metalliferous Minerals and Precious Metals Lode leases
Class B--Metalliferous Minerals and Precious Minerals Alluvial leases
Class C--Mica leases
Class D--Precious Stones leases
Class E--Carbonaceous Minerals leases
Class F--Earthy Minerals leases

The minimum area of a Class A or Class B mining lease is 5 acres, and the maximum areas for these leases are 50 acres and 800 acres, respectively. The area requirement of a Class C, D, E, or F lease is prescribed by the regulations. The lessee is obliged to commence effective mining operations within 6 months of the date of the lease, and to carry on such operations continuously. The work requirements set forth in the regulations vary with the different classes of leases, and are subject to modification by the Government Inspector of Mines when he is satisfied that the mining operations are being carried out vigorously and effectively.

Under Section 67 of the Ordinance the Minister is authorized to make detailed regulations regarding all facets of the mining operations, including the establishment of rental fees and royalties. A mining lease may be surrendered at any time 6 months after notice in writing is given to the Government Inspector of Mines, and may be assigned only with the consent of the Minister.

## Special Mining Lease

The Minerals (Amendment) Ordinance, 1967, gives the Minister the power to grant special mining leases. Such leases are still subject to the provisions of the Ordinance and regulations related to mining, but the Minister has discretion to waive these limits and conditions. Special leases must be ratified by the House of Representatives, but if the House takes no action within 60 days, the Minister may again act at his discretion.

## Radioactive Minerals

Radioactive minerals are governed by Law No. 3 of 1949, which requires a special license from the Minister to prospect, mine, or export these materials. In all matters under this law the Governor has absolute discretion and is not required to give any reasons for his actions. A monthly report of all activities must be made to the Government.

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## Petroleum

The original petroleum legislation in British Honduras was the Oil Mines Ordinance No. 32 of 1920, which was applicable only to Crown lands and recognized the private ownership of "oil mines" located in lands prior to that Ordinance.

The controlling law at present is the Petroleum (Production) Ordinance, Chapter 126 of the Laws of British Honduras, Revised Edition 1958, which is based on Ordinance No. 17 of 1937, and the Oil Mining Regulations (Statutory Instrument No. 56), 1949, as amended. The law declares that all petroleum existing in its natural condition in strata of British Honduras is vested in Her Majesty, who has the exclusive right of searching for, boring for, and obtaining such petroleum. On behalf of Her Majesty, the Minister may issue exploration licenses, prospecting licenses, and mining leases.

The terms for exploration and prospecting licenses and mining leases are not specified by the Ordinance but are left to the regulations. The Oil Mining Regulations of 1949 (article 4, paragraph 6) state that model clauses (not published but available for inspection at the Ministry of Natural Resources and Trade) may or may not be used in any particular license or lease, as the Minister deems necessary.

There is no limit on the number of licenses or leases that may be granted to one person or company. To obtain a license or lease a foreign corporation may be required, in addition to having a duly authorized agent in the colony, to incorporate in the colony or in some other part of the British Commonwealth.

Licenses and leases can cover Crown lands, or alienated lands, or both Crown lands and alienated lands. Before a license or lease can be granted, ancillary rights must be obtained from the owner of the land, who receives a 5-percent royalty on any oil which but for the Ordinance would be vested in him. If for some reason such rights cannot be obtained by the licensee or lessee on reasonable terms, the Minister may grant such rights on such terms and conditions as he shall see fit, subject to the payment of compensation to the persons affected. Ancillary rights include all rights and privileges necessary for the exploitation of petroleum, specifically (1) the right to enter and explore land geologically for petroleum, (2) the right to sink bore holes, (3) the right to erect buildings and other works required for searching, storing, and treating and converting petroleum, and (4) the right to use water in the mining operations.

### Oil Exploration License

An oil exploration license, subject to a minimum area requirement of 8 square miles, may be granted at the discretion of the Minister. The initial duration of the license is for 2 years subject to renewals of 1 year each up to a maximum term of 4 years. The application fee is US$35. The license fee is set at US$175 per 1,000 square miles, with the minimum fee being US$350 and the maximum fee being US$3,500.

### Oil Prospecting License

An oil prospecting license may be granted by the Minister over specified lands, irrespective of whether or not the applicant has been a holder of an oil exploration license. Subject to the rights of an applicant who is the holder of a valid oil exploration license, the granting of an oil prospecting license is at the discretion of the Minister.

The minimum area for which a license may be granted is 8 square miles and the maximum area is 200 square miles. Under the regulations the Minister may grant a comprehensive oil prospecting license with respect to two or more separate areas if situated reasonably close together and the total area does not exceed 200 square miles.

The initial term of the license is 4 years, and a 1-year renewal is permitted at the discretion of the Minister.

The licensee is under the obligation to carry out with due diligence a program of prospecting, including any geological or geophysical survey or program of test drilling, agreed upon by the Director of Surveys and the licensee.

### Oil Mining Lease

An oil mining lease may be granted, at the discretion of the Minister, for areas previously included either in an oil prospecting license granted to the applicant or in an oil mining lease granted to the former lessee. Additional areas adjoining that already held by an applicant under an oil mining lease may be granted.

The initial term of an oil mining lease is 30 years, renewable once for an additional 30-year period. The minimum area for which a lease may be granted is 4 square miles, and the maximum area is 100 square miles. Subject to the regulations, the Minister may grant comprehensive oil mining leases encompassing two or more areas, provided they are situated on the same geological structure or cover a group of geologically similar or related structures, and provided further that the sum of such areas shall not exceed 100 square miles.

Each area for which a mining lease is granted is to be either limited by permanent physical boundaries or to be laid out in a block or blocks bounded by straight lines between well defined points. The length is not to exceed three times the width for a 4-square-mile area, or five times the average width for a 100-square-mile area. In the case of an area of intermediate size, the maximum ratio may vary between three and five, in proportion to the size of the area. Before the oil mining lease is granted, the Minister may require the applicant to have a topographical survey made of the lands on a scale normally required for mining purposes.

## Fiscal Provisions

1. Rents. The annual rent payable for an oil prospecting license per square mile of licensed area is US$0.70 for each year of the initial term and US$1.40 for each renewal term. The minimum rent payable for the initial term is US$30, and the minimum payable for renewal term is US$70.

The annual rent payable for an oil mining lease per acre of lease area is fixed on a graduated scale ranging from US$0.30 for the first 3 years up to US$2.10 for the 10th and subsequent years. The rent paid by the holder of either an oil prospecting license or an oil mining lease is deductible from royalties.

2. Royalties. The holder of an oil prospecting license is under the obligation to pay the following royalties: (1) 12-1/2 percent of the value of oil on crude oil and casinghead gasoline and (2) US$0.028 per 1,000 cubic feet sold on natural gas, subject to a reduction of one-half when the gas is sold to other licensees or lessees for repressuring purposes.

The holder of an oil mining lease is under the obligation to pay the following royalties: (1) 12-1/2 percent of the value of oil on crude oil, (2) 10 percent of the value of production on casinghead gasoline up to 2 Imperial gallons and 12-1/2 percent of the value of oil on production over 2 Imperial gallons per 1,000 cubic feet of gas treated, and (3) US$0.028 per thousand cubic feet sold on natural gas, subject to a reduction of one-half where the gas is sold to other licensees or lessees for repressuring purposes.

Royalties for leases are to be assessed and paid as provided in the model clauses of Part III of the Second Schedule. Additionally, every oil mining lease must contain a clause providing for periodical revision of royalties in the manner provided in Part III of the Second Schedule.

3. Income Tax. Income from petroleum operations is subject to a tax of 50 percent on net profits, under the provisions of Act No. 11 of 1963, cited as the Income Tax (Petroleum) Ordinance, 1963.

# COSTA RICA

## Controlling Statutes

The principal legislation governing mining in Costa Rica is the Mining Code of April 20, 1953 (Decree Law No. 1551), supplemented by a chapter dealing with aluminum deposits contained in Decree Law 3376 of August 8, 1964; however, it does not apply to coal, petroleum or other hydrocarbons, or radioactive minerals. It is reported that new mining and petroleum laws are under consideration.

## Administration

The Ministry of Industries, through its Department of Geology, Mines and Petroleum, is entrusted with matters pertaining to the discovery of mines, exclusive exploration permits, denouncements and permits for the exploitation of minerals, as well as enforcement of obligations imposed by law.[1] The production and use of radioactive materials is supervised by the Atomic Energy Commission of Costa Rica.

## Mining Law

All mineral deposits are the property of the state and are not subject to private appropriation, although the state may grant mining rights for the exploration and exploitation of the subsoil. With the exception of the owners of the land, who have first option to exploit stone, sand, and similar building materials found on their property, rights to extract all other minerals are obtained under the general regulations of the Mining Code.

There appear to be no restrictions on citizens and foreigners obtaining mining rights anywhere in the Republic, with the exception of employees of a mining enterprise (who are prohibited from acquiring mining rights on discoveries located within 10 kilometers of the mining claims on which they are employed) and certain Government officials. Foreigners, whether individual or corporate, are accorded the same rights as citizens, but they are subject to the jurisdiction of courts and other authorities and may not resort to diplomatic intervention except as provided in international conventions.

### Exploration

Anyone may excavate and explore for mineral deposits, provided no damage is done to private property. Upon making a discovery, a prospector may denounce the deposits and seek an exploitation permit. No exploitation may be carried out without the appropriate permit from the Government.

An exclusive exploration permit may be granted upon application to any individual for specified areas of public lands. Exploration permits are granted for a period of 1 year for areas of 10 to 400 hectares, but for larger areas the permit is valid for 3 years. Upon the recommendation of the

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[1] For information, write Departamento de Geologia, Minas y Petroleos, Ministerio de Industrias, San Jose, Costa Rica.

Department of Geology, Mines and Petroleum a renewal may be granted for up to 1 year. With regard to the 3-year permits, one-third of the area covered by the permit must be surrendered each year in order to obtain an extension.

The holder of an exploration permit has a 1-month option privilege in which to initiate proceedings for the denouncement of mineral deposits discovered within the area covered by the permit. If the exclusive permit expires, another permit covering the same area may not be granted to the same natural or juridical person until 1 year after the date of expiration.

Discovery of a mineral deposit should be recorded in the Registry of Discoveries along with a sample of not less than 1 kilogram of the mineral. Registration confers a preference right for 3 months to make a denouncement and obtain an exploitation permit.

## Exploitation

While a denouncement is a necessary prerequisite to obtaining an exploitation permit, it need not be preceded by previous registration in the Registry of Discoveries. Certain detailed information concerning the applicant and the area claimed must be stated in the application. If the denouncement is in order and no objections are filed, the Department issues an order granting an exploitation permit.

The mining unit is a "pertenencia," a vertical prism of indefinite depth whose surface is a square with an area of 4 hectares. Pertenencias may be mining pertenencias, placer pertenencias, and pertenencias for lateral support. A placer pertenencia is limited in depth to the thickness of the placer deposit. Fifty pertenencias is the maximum which may be granted to any one person or corporation in the same district.

The holder of an exploitation permit has the following rights: (1) to exploit any minerals for which the permit was granted, (2) to construct works for access, drainage, and ventilation passing through adjoining claims or through private property, (3) to obtain necessary easements for exploitation of the deposit, (4) to lease areas of adjacent public lands which are necessary to facilitate exploitation, and (5) to utilize any timber or water on the claim or neighboring public lands necessary for exploitation purposes.

A concessionaire has the following obligations: (1) To maintain proper boundary markings, (2) to pay taxes in advance, (3) to start exploiting the deposit within 2 years, (4) to submit reports every 6 months, (5) to furnish assistance to inspectors and other Department officials, (6) to comply with all labor and social legislation, (7) to compensate surface owners for loss or damage, and (8) to satisfy all other obligations specifically mentioned in the Mining Code.

Mining rights are lost if financial obligations are not met or if work is interrupted for 2 years, unless the cause of the interruption is considered justified by the Department of Geology, Mines and Petroleum.

## Fiscal Provisions

Holders of exclusive exploration permits must pay an annual tax of 2.50 colones (1 colon = US$0.15) per hectare. Holders of exploitation permits must pay annual taxes of 50 colones for each mining pertenencia and 200 colones for each placer pertenencia. After the first 2 years and so long as work is regular and continuous, the holder only pays 25 percent of the rates indicated. If the work is interrupted without good reasons, the holder must pay 50 percent more than the stated rates.

Discoverers of mineral deposits, except placers, are exempt from payment of taxes for 2 years on two mining claims in a new zone and on one in an old zone. Claims exempt from payment are known as premium claims (pertenencias de premio).

## Special Mining Laws

Law 3376 of August 25, 1964, added a special chapter to the Mining Code dealing with aluminum minerals. This chapter provides that the Executive is authorized to grant larger concessions for aluminum than those stipulated in other chapters of the Code. The maximum area for an exploration concession is 250 square kilometers, one-third of which is reserved to the Government, when the concession is converted to exploitation. Subject to prior approval of the Legislative Assembly, the one-third of the area reserved may also be granted as a concession by the Executive. In such a case, the person who made the original exploration shall have priority during an option period of 30 days. Law 3376 also contains provisions dealing with the duration of concessions, rules for taxation, and the minimum amount of work required, and it further authorizes establishment of aluminum mineral reserves.

## Petroleum

There is no general petroleum law in force in Costa Rica at present.[2] Petroleum may be exploited only according to special contract provisions which are subject to the approval of the Assembly.

Since there is no petroleum law applicable, the Cia. Petrolera de Costa Rica (owned by Union and Gulf Companies) contract of April 25, 1951, is a good indication of the demands of the Assembly. The contract provides for an exploration period of 4 years, renewable upon agreement for 2 more years, to be followed by a 40-year exploitation period, if commercial oil is found. The concession originally covered approximately 3 million acres of land. A cash bonus of $18,000 was paid, and the concessionaire was obligated to spend at least $200,000 during the first 2 years and an equal amount during the following 2 years. No drilling obligation was stated, but the concessionaire is required to produce within the first 10 years at least 500 barrels daily for each exploitation lot (10,000 hectares). Royalties range from 10 to 16-2/3 percent, depending on the quantity of production. The concession contemplates an equal division of profits between the Government and the

[2]Article 121 of the Constitution of 1949 provides that petroleum resources are permanently the property of the state.

concessionaire when commercial production is achieved, the royalty being credited against the Government's share. The concessionaire is exempt from export duty on petroleum and petroleum products, as well as from import duty on goods, so long as his production is below 5,000 barrels per day. There is no provision for extension at the expiration of the 40-year exploitation period.

A new concession law is reported to be under study. Its provisions include the following:

### Exploration

The term of an exploration concession is 4 years, and the concession is renewable for 2 years if, at the end of the 4-year period, the concessionaire has a rig working which is capable of drilling to 12,000 feet. The number of concessions owned by one person is limited to 30, each concession having a maximum area of 12,500 hectares.

### Exploitation

The maximum term for an exploitation concession is 40 years with no provisions being made for renewal. The maximum area of an exploitation concession is one-half the exploration area. No more than 150,000 hectares may be held by a single concessionaire.

### Fiscal Provisions

An annual exploration surface tax of 18 cents per hectare is proposed, with reductions based upon exploration expenditures. When commercial production is achieved, the proposed code provides for an equal division of profits, 50 percent to the state and 50 percent to the concessionaire, and royalties at 16-2/3 percent of gross production.

# DOMINICAN REPUBLIC

## Controlling Statutes

The principal mining legislation in the Dominican Republic is the Mining Law 4550 of September 23, 1956, as amended by Law 5426 of November 11, 1960. With the exception of petroleum and other hydrocarbons, this legislation applies to all minerals. Development of petroleum resources is governed by Petroleum Law 4532 of August 30, 1956, and by Law 4833 of 1957.

Administration of the mineral laws is entrusted to the Mining Administration (Direccion de Mineria).[1]

Minerals are the property of the State and may be exploited only under contracts or concessions authorized by law. Mineral rights may be granted to foreigners on the same terms as to Dominicans, but only when the foreigners agree to subject themselves expressly and exclusively to the jurisdiction of the laws of the Dominican Republic. Foreign governments may not obtain mining concessions.

## Mining Law

Mineral substances are divided into two basic categories: (1) Mines that include metal- and nonmetal-bearing minerals as well as mineral carbons, and (2) stone, peat bogs, and sand quarries.

## Reconnaissance and Exploration

With the exception of areas already covered by an exploration permit or exploitation concession, surface reconnaissance may be carried out freely throughout the Republic. Permission to enter private property must be obtained from the owner, and compensation must be paid for any damages. When any indication of the presence of a mineral substance is found, a claim, accompanied by mineral samples for analysis by the Government, may be filed in the master registry at the Direccion de Mineria. Registration gives the holder a 90-day prior right to an exploration permit or mining concession.

Exploration permits may be obtained if the area requested is not already covered by a permit or concession or is not reserved in the public interest as, for example, a military zone. The duration of a permit may not exceed 2 years. A permit may be transferred only when approved by the Direccion de Mineria. Minerals may not be exploited under a permit. The holder may relinquish the permit at any time upon notification, or the Administration may declare it lapsed, if exploration work is not begun within 3 months after the permit is issued, or other regulations are violated.

[1] For information, write Direccion de Mineria, Secretary of Industry and Commerce, Santo Domingo, Dominican Republic.

Production Concessions

1. Prospecting concession.--A concession for prospecting consists of 16 mining hectares,[2] less any area that is held under prior concession title. It has a nonrenewable term of 2 years and is not subject to the special surface tax. The holder of the concession is entitled to use all minerals obtained by his efforts and has the exclusive right to apply for an exploitation concession during the 2-year term. No individual or entity may hold more than one prospecting concession at any one time.

2. Exploitation concession.--Exploitation concessions which may be obtained for the surface area requested are issued for an unlimited time. Under Law 5491 of February 17, 1961, a concessionaire is obligated to begin exploitation within a period of 1 year after preliminary work has been completed. The concessionaire may install and operate plants for treating minerals and establish any other necessary facilities. New minerals discovered, distinct from those originally specified in the concession, may be exploited when the Direccion de Mineria is notified.

3. Processing concession.--Concessions for operating treatment plants authorize operation of a single plant for an unlimited period. The concession sets forth the minimum capacity, the budget, the location, and the terms for beginning and completing the construction work. Treatment plants are required to accept for treatment ores of third parties up to 20 percent of their capacity.

All concession holders have the right to enter upon the lands within their concession but must indemnify the owner of the land for any damage. Land for installation, plants, and ore dumps may be obtained by requesting expropriation by the Secretary of Industry and Commerce through the Direccion de Mineria. After compensation is paid, concession holders may drive necessary underground workings through free or open land or other concessions for reasons of safety or economy.

Quarries of stone, marble, granite, feldspar, and peat bogs and sand deposits may be freely exploited by the landowner. Such deposits may be made the subject of an exploitation concession, the holder of which must indemnify the landowner for the value of the material exploited.

The filing fee for an exploration permit is 2 pesos (1 peso = US$1.00) accompanied by a deposit of 50 pesos, which is returned if the petition is not granted. The application must contain the name, residence, personal identity and number, and scale maps showing boundaries of the selected area.

The filing fee for a concession is also 2 pesos. The concession application must contain information similar to that for a permit, and also technical and economic reports on the mineral deposit or work planned; a company must provide a copy of the charter and bylaws and a certificate listing the names

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[2]The mining hectare, which is the concession unit, is defined as an area 100 meters square and of unlimited depth.

and positions of the technical personnel in charge. Prospecting concessions cost 75 pesos in fees, and exploitation or processing concessions 500 pesos. Certain other small fees must be paid.

Concessions may be transferred with the approval of the Secretary of Industry and Commerce. A concession may be renounced by the holder at any time; the State then becomes the direct owner of the mine, plants, and all appurtenances.

An exploitation concession is subject to a surface tax based on a sliding scale commencing with 10 cents per hectare for the first 3 years and increasing to 1 peso per hectare beginning with the 10th year after the concession was granted. These amounts may be reduced when certain investment schedules are met or when production of the mineral becomes uneconomic.

A tax on net profits is payable, the rate being 5 percent of net profits during the first 5 years and increasing to a maximum of 30 percent after 25 years. This tax applies to minerals which require treatment or beneficiation within the country. When minerals are exported in their natural state without beneficiation, special contracts must be entered into with the Government, covering the payment to be made. Concessionaires are entitled to such tax exemptions as may be specified in the contract or concession.

## Petroleum

Under Petroleum Law 4532 of 1956 and Law 4833 of 1957, deposits of petroleum, asphalt, naphtha, bitumen, tar, ozocerite and other hydrocarbons may be explored, exploited, and beneficiated only under individual contracts between the Government and the concessionaire. Any contracts granted by the Executive Power must be approved by the National Congress and may not be revoked or altered without the consent of both contracting parties. Contracts may be granted only to Dominican citizens or companies, or to foreign individuals or companies submitting themselves to the exclusive jurisdiction of the Dominican Republic. Contracts, unless they specify to the contrary, may be assigned in full by the holder and may also make special provisions for exemptions and reduction of taxes. All contracts are to be registered publicly in the Direccion de Mineria.

# EL SALVADOR

## Controlling Statutes

The principal legislation governing both mining and petroleum in El Salvador is the Mining Code of 1922, as amended by the Complementary Mining Law, Decree 930 of January 21, 1953.[1] Special rules apply to phosphates, petroleum, and other hydrocarbons.

Mineral rights may be obtained by both citizens and aliens.

## Administration

Under the Ministry of Economy, the Department of Economic Promotion has assumed the administrative powers of the Departmental governors. It is the function of this Department to rule on applications for concessions and generally enforce the laws to which mining activities are subject.[2]

The Complementary Mining law of 1953 supplements the administration of the mining code by permitting the Director General of Commerce, Industry and Mining (now called Department of Economic Promotion) to appoint for each mine under exploitation a "mine commissioner" entrusted with the supervision and inspection of mining activities. These commissioners are directly responsible to the Department of Economic Promotion and serve in a general policing and technical administrative capacity.

## Mining

The State owns all minerals except those of a common nature, such as construction and industrial materials, and salt mines, which belong to the owner of the land. Petroleum, bituminous minerals, and phosphates are subject to special rules. Rights to all other minerals may be obtained by denouncement as described below.

Ownership of a mine, which is separate from ownership of the surface estate, is acquired through a formal adjudication following satisfaction of specified requirements. No concession may be granted unless there has been a discovery.

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[1] Other laws include (1) Decree 106 of July 23, 1937, as amended by Decree 65 of September 30, 1940, and Decree 100 of December 20, 1941, which relate to exemptions for mining activities, (2) Decree 52 of September 10, 1940, as amended by Decree 78 of November 15, 1940, and Decree 109 of March 31, 1949, which relate to control over gold, silver, and other precious metals, and (3) Decree 2326 of January 29, 1957, which provides that the Ministry of Economy shall include a Department of Economic Promotion entrusted generally with the stimulation of the mining activities of the country.

[2] For information, write Departmento de Promocion Economica y Asuntos Industriales, Ministerio de Economia, San Salvador, El Salvador, C.A.

## Exploration Permits

An exploration permit authorizes an individual to prospect and excavate lands for the purpose of seeking minerals. Priority is given to the first applicant. The permit gives the holder an exclusive right to make denouncements of mining claims within his exploration area. This area is defined as a circle with a radius not greater than 500 meters drawn from a well-defined point. A permit has an initial duration of 60 days and may be renewed for 60-day periods, but the total period may not exceed 1 year.

## Denouncement of Claims

Any prospector who discovers a mineral can apply for a concession. He does not have to hold a permit in order to denounce a claim. Written notice of a discovery on open land constitutes denouncement of a mine. This notice is entered in the book of denouncements and must be accompanied by a sample of ore. The person making the denouncement acquires a priority to a concession. Within 6 months, specified development work must be completed. Following publication of notice, marking of boundaries, and making a survey, the discoverer may apply to the Department of Economic Promotion for a concession.

Concessions are granted in perpetuity, but their duration is subject to compliance with the conditions of the concession, including work requirements.

A claim, which is the unit of mining property, is a prism bounded by four vertical planes. At the surface, it is a square with 100-meter sides oriented N-S and E-W. A concessionaire owns all minerals within his claim, except those subject to special concessions. If a discovery is made at a distance greater than 10 kilometers from the nearest similar mine, the discoverer has a right to 10 continuous claims on the vein discovered, and five additional claims on each of any other veins he discovers. Otherwise, a discoverer is entitled to not more than eight continuous claims.

The code declares that the mining industry is a public utility, and consequently mine owners have certain rights of condemnation. Rights of transit, drainage, and ventilation are provided.

A concession will be terminated if (1) preliminary development work is not undertaken within 6 months, unless an extension is obtained, (2) work is suspended for 6 consecutive months without good reason, (3) the mine is exhausted and no new exploration work is started within 3 months, or (4) the holder fails to comply with the code and other applicable laws.

An annual or semiannual fee is payable in an amount determined by the Executive Power, based upon the mineral for which the concession was granted.

## Petroleum

Articles 204-208 of the Mining Code govern the development of petroleum resources. Special legislative approval is required for petroleum concessions. The form of concessions, including duration, area, and other terms, is determined by the Executive Power.

The holder of a petroleum concession must pay a tax of not less than 50 percent of distributed profits.

# FRENCH OVERSEAS DEPARTMENTS: GUADELOUPE, MARTINIQUE, AND FRENCH GUIANA

## Controlling Statutes

French Decrees No. 55-586 of May 20, 1955, and No. 56-1039 of October 5, 1956, govern the development of mineral resources, including petroleum, in Guadeloupe, Martinique, and French Guiana.[1] These territories are overseas departments of France.

## Mining and Petroleum

Mineral deposits are classified as mines and quarries. Quarries include all building materials, fertilizers, and similar substances, but not nitrates and associated salts and phosphates. Title to quarriable deposits is vested in the surface owner, and the acquisition of rights to quarries is not governed by the basic mining law.

Foreign individuals who are domiciled in an overseas department may acquire mining rights. The right to engage in mining activity was extended to citizens and companies of European community countries by Decree 62-756 of June 30, 1962.

### Personal Authorization

A personal authorization is a prerequisite for carrying out prospecting and exploration work. This authorization is issued for a 5-year period and entitles the holder to a limited number of permits or concessions. It confers the right to prospect for one or more mineral substances in areas not closed to prospecting or exploration by official decree or by reason of existing private rights. The licensee obtains the right to demand an exploration permit and to request an exploitation permit. Licenses are not exclusive and are subject to cancellation without indemnity by the prefect upon advice of the Chief of the Mining Service.

Application for a personal authorization and a copy to the Chief of the Mining Service should be addressed to the appropriate prefect. The application must contain (1) a statement identifying the applicant, (2) an enumeration of substances for which the license is requested, (3) the number of permits and concessions for which the license is sought, (4) the objectives and financial resources of the applicant, and (5) a list of existing permits and concessions held by the applicant.

## Exploration Permits

Exploration permits fall into three categories: A, B, and ordinary. Class A permits are granted at the discretion of the administration and may cover any substance open to concession. Class B permits are limited to reserve zones. Petroleum locations are declare reserve zones. They are

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[1] For information, write to Monsieur le Chef du Service des Mines, Boite Postale 230, Cayenne, French Guiana.

closed to foreign control, although it appears that foreign minority interest is possible in companies that have received the joint approval of the Ministers of Finance, Economic Affairs, and Industry and Commerce. There is no geographical limitation on A and B permits, which are effective for 5 years with a right of renewal. Ordinary exploration permits, issued according to the priority of applications for 2-year periods, embrace 25 square kilometers. Ordinary permits confer no right to explore for petroleum or atomic energy substances.

### Exploitation Permits and Concessions

Exploration permits entitle their holders to an exploitation permit or mining concession when the claim is shown to have potential fruitful exploitation. The conditions and duration of class B and ordinary exploration permits carry over into the derivative exploitation permits or concessions. Exploitation permits or concessions deriving from class A permits are subject to the same conditions as those deriving from a comparable class B exploration permit.

Mining concessions are available upon application to the Minister of Mines. He settles disputes between applicants for conflicting concessions. Concessions may be amended upon application and last for the term specified as long as all conditions are met.

When made available to private companies, substances connected with producing atomic energy are exploited under strict administrative control. Restrictions on foreign holdings parallel those for petroleum.

# GUATEMALA

## Controlling Statutes

The laws governing mining are the Mining Code of Guatemala, Decree Law No. 342 of April 22, 1965, published May 4, 1965, and the Regulations for the Application of the Mining Code, Decree Law No. 342 of March 3, 1967. Development of petroleum resources is governed by the Petroleum Code of Guatemala, Decree 345 of July 7, 1955, and Regulations, published October 27, 1955.

## Administration

The Ministry of Economy and the Bureau of Mines and Hydrocarbons,[1] a technical administrative agency, are responsible for the administration of these laws. The Mining Code creates the National Mining Commission, an advisory and technical consulting body, which issues opinions on the technical aspects of the Code relating specifically to reconnaissance, exploration, and exploitation of mineral resources.

Disputes regarding mineral rights are generally submitted to the Bureau of Mines and Hydrocarbons or the Ministry of Economy. Administrative appeals from the decisions of these agencies may be taken to the Court of Contentious-Administrative Affairs, and finally an appeal may be taken to the Supreme Court. Matters of a contentious nature according to ordinary legislation are heard before the Courts of Justice.

## Mining

The ownership of all minerals, with the exception of quarries, is vested in the State and is unalienable. All mineral deposits not falling within the definition of quarries (construction and ornamentation materials) are subject to the Mining Code, except petroleum and radioactive minerals.

Any qualified person, individual, or corporation, national or foreign, may acquire a reconnaissance license or exploration concession, with the exception of foreign governments or companies in which they have an interest, and certain public officials of Guatemala. In granting exploration concessions, preference is given to Guatemalan citizens and corporations with more than 50 percent of capital owned by Guatemalans. Exploitation concessions can only be granted to individual Guatemalan persons and to juridical persons incorporated in Guatemala.

There are several limitations applying to foreign citizens or foreign-controlled corporations incorporated in Guatemala who wish to own land in order to exploit minerals. These limitations apply to (1) frontier zones, where no rights may be obtained within 15 kilometers of the frontier, (2) coastal regions, where no rights may be obtained within 3 kilometers of the coast, (3) shores of national lakes, where no rights may be obtained within 200 meters of the shore, and (4) navigable rivers, where foreigners may not own land within 100 meters of a river.

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[1] For information, write Direccion General de Mineria e Hidrocarburos, 10 a Calle 11-46 Zona 1, Guatemala, Guatemala.

## National Reserves

There is an additional limitation which applies both to Guatemalan citizens and to foreigners with regard to obtaining concessions within specified areas set aside as National Reserves. (As of February 1966, this land included roughly one-fifth of the national territory.) These areas have been temporarily or permanently closed to mining activities in the public interest, although the Guatemalan Government will consider applications for concessions which appear to be of exceptional interest.

Alluvial minerals are generally of free utilization, provided they are exploited by a manual process. All that is necessary to work in the zones of free utilization is a renewable miner's card which is valid for 5 years.

## Reconnaissance License

A reconnaissance license gives the holder a nonexclusive right to prospect for mineral substances in all lands except those which are subject to exploitation concessions. In areas subject to exploration concessions, reconnaissance may be carried out only for those minerals not included in the concession. Reconnaissance in privately owned lands may be carried out only with the consent of the owner of concerned Government office. Licenses are issued for 1-year periods and may be renewed twice for the same period. The reconnaissance license does not give a priority to an exploration or exploitation concession. If the holder makes a discovery, he is entitled to 1 percent of the annual net profit from exploitation if the exploitation concession is granted to another individual. This right to 1 percent of the profit continues for the term of the exploitation, but in no case for more than 20 years.

## Exploration Concession

An exploration concession gives an exclusive right to perform any work tending to establish the existence and exploitability of the mineral for which it was granted, including extraction, exportation, and utilization of limited quantities of the ore. A concession has a term of 1 to 3 years, and may be renewed, subject to a maximum duration of 5 years. Upon obtaining a renewal, the concessionaire must surrender 50 percent of the area of the original concession. The holder of the exploration concession has the right to be granted an exploitation concession if he proves the existence of a commercially exploitable deposit.

A concessionaire has the following obligations: (1) to invest a specified annual sum in exploration work, (2) to submit an annual report containing data on technical, financial, and operational matters, and (3) at the termination of the concession, to furnish to the Bureau of Mines and Hydrocarbons any documents requested of him relating to the exploration work.

There appears to be no limitation on the number of concessions which one individual may hold. A concession may be in the shape of an irregular polygon, the area of which may be a minimum of 10 square kilometers and a maximum of 5,000 square kilometers.

A concessionaire may at anytime exercise his right of partial or total relinquishment, provided he has satisfied all his obligations.

## Exploitation Concession

An exploitation concession gives an exclusive right to exploit the mineral substances named therein, as well as the right to extract other associated mineral substances which may be found in the concession area. No individual or corporation may acquire more than 500 square kilometers in exploitation concessions. Each concession must be within the perimeter of the exploration concession from which it was derived and generally must be in the shape of a rectangle, oriented N-S and E-W, with a maximum area of 20 square kilometers.

The term of an exploitation concession is 40 years, renewable for 20 years. Three years prior to the expiration of a concession, the Executive may elect either to undertake exploitation on its own behalf, or to grant a new concession giving the present concessionaire preferential treatment.

Exploitation concessions are granted by the Executive, following application by the holder of an exploration concession, posting of notice, advising local authorities, publishing notice, surveying, hearing any opposition, and approval by the Council of Ministers. The applicant must possess financial and technical capacity. The concession may be denied when the public interest requires, in which case the applicant shall be indemnified for his expenditures.

Within the limits of the concession the holder may carry out any of the activities normally associated with the exploitation of minerals. Outside the limits of the concession, he may carry out all operations necessary for the development of the mine, such as concentration, beneficiation, transportation, and sale of the mineral production. A concessionaire is entitled to a number of temporary easements and rights with regard to the use and utilization of the land and waters of Guatemala. Subject to indemnification, these provisions include the right to cut timber, transit private property, produce electric power, construct aqueducts and sewers, and use, in accordance with civil legislation on water rights, the waters found in and outside their concessions.

The holder of the exploitation concession is under the obligation to (1) submit annual written reports containing financial and technical data, (2) after the sixth year of exploitation, make a minimum annual investment in capital goods or operating expenses, (3) provide scholarships for Guatemalans to undertake specialized training, preferably in professions related to mining, and (4) formulate safety regulations satisfactory to the Bureau of Mines and Hydrocarbons in concessions with over 10 workers.

## Termination of Rights

The Ministry of Economy may declare the lapsing of concessions if taxes are not paid, minimum investments are not made, important operations are not performed, or the concessionaire refuses to cooperate with the officials of the Bureau of Mines and Hydrocarbons.

In the event of termination of the concession, all permanent installations which permit the continuation of mining operations pass to the State, without compensation.

The holder of an exploration concession may relinquish his concession in whole or in part by filing a statement with the Bureau of Mines and Hydrocarbons. With authorization from the Ministry of Economy, the holder of an exploitation concession may relinquish at any time part or all of his concession, provided that it is not encumbered and that he has fulfilled all his obligations.

With regard to employment, Guatemalans have a preferred status provided they have the requisite technical ability, and concession holders are obligated to employ nationals for at least 80 percent of their work force. Guatemalan personnel must earn not less than 85 percent of the total salaries paid.

The State has a priority to purchase mineral production, which is indispensable for satisfying the needs of the country, subject to payment at world prices.

## Fiscal Provisions

The Code provides that reconnaissance licenses shall be tax free. Holders of exploration and exploitation concessions are under the obligation to pay the following:

1. Issuance tax.--A fixed sum paid only once (generally for exploration, 1 quetzal (1 quetzal = US$1.00) per square kilometer; exploitation 50 quetzales per square kilometer).

2. Surface Taxes.--A graduated tax ranging from 20 quetzales per square kilometer the first year to 100 quetzales per square kilometer the ninth year, but paid only by exploitation concession holders.

3. Royalties.--A direct and proportional tax (7 percent) on the gross value of the extracted mineral at the mine, based on the price in the international market at the time of extraction. The State is paid 5 percent of the royalty; 1 percent is paid to the owner of the land where the exploitation is being carried out, and 1 percent to the local community.

4. Income Tax.--Exploitation concession holders are subject to the Income Tax Law (Decree Law No. 299, as amended). Special tax advantages are given to concessionaires who establish mineral refining installations. The issuance tax, surface tax, and royalties may be deducted in computing net income.

Concessionaires may import free of customs duties any mining related materials, provided they are not produced in Guatemala in sufficient quantity or quality.

## Petroleum

All petroleum operations except marketing are declared to be a public utility, and all petroleum resources are the property of the State. The State may conduct petroleum operations directly, or may grant petroleum rights to qualified individuals or corporations, national or foreign, who have a residence in Guatemala. A corporation organized in Guatemala with foreign stockholders must offer 30 percent of its stock to Guatemalans for a period of 90 days.

Foreign governments, companies under the control of foreign governments, and certain public officials are not eligible for petroleum rights. Foreign-controlled corporations may be denied permission to operate within 15 kilometers of borders.

The State may designate areas as National Reserve Zones, within which petroleum rights may be granted only by competitive bidding following noncompetitive bidding by Guatemalans.

### Exploration

Exploration rights are of two types: surface reconnaissance and the the exploration concession. A surface reconnaissance permit authorizes nonexclusive prospecting work in areas not subject to exploration or exploitation rights, but it does not include the right to carry out drilling or geophysical operations. Before commencing operations the holder must furnish U.S. $10,000 bond and obtain the consent of the surface owner. If the owner refuses to allow reconnaissance the holder has recourse to the courts. A written report concerning findings must be submitted every 6 months.

Exploration concessions convey an exclusive right to conduct all exploratory operations, including drilling and definition of any discoveries, and to produce petroleum. The term of an exploration concession is 6 years, and two 2-year renewals are permitted. The area of a concession may be between 5,000 and 400,000 hectares. One person or company may not control more than 10 concessions.

The following are the obligations of the holders of exploration rights: (1) To begin and continue exploration work within 90 days, (2) to invest minimum amounts on a graduated scale, 90 centavos per hectare during the first 3 years up to 40 centavos per hectare during the seventh and subsequent years, (3) to advise the Bureau of Mines and Hydrocarbons of discoveries of petroleum in commercial quantities within 15 days, (4) to pay annual surface rentals, royalties, and applicable taxes, (5) to mark at least two diagonal corners or a reference point within the first 3 years, and (6) to advise the Bureau of Mines and Hydrocarbons 30 days in advance of a renunciation of their rights.

The procedure for filing applications for petroleum rights is outlined in articles 165 to 169 of the Code. The application fee is $500, 75 percent of which is returnable if the concession is not received. If the application is in order it is published in the Diario Oficial by the applicant, and in

another newspaper of Guatemala City, three times during the course of 30 days. During this 30-day period, opposition to the granting of the right may be presented, and a similar 30-day period is allowed for hearings. Final decision must be rendered within 60 days; a favorable decision is published in the Diario Oficial, and title is granted within 15 days of the publication. The date of the presentation of an application determines its priority. If applications are presented on the same day, the concession is awarded through competitive bidding.

The discovery of petroleum in commercial quantities obligates the holder to delimit the field within 5 years and select land for his exploitation concession which will be automatically granted for a 40-year period, with a right to a 20-year extension. When an exploration right is converted into an exploitation concession, either as a result of a discovery or because the holder wishes to do so for other reasons, the holder must return to the Government 50 percent of the exploration area.

## Exploitation

An exploitation concession conveys an exclusive right to extract, store, transport, sell, and export petroleum, and to undertake any work necessary for such purposes. No provision is made in the Code for direct acquisition of an exploitation concession.

The area of an exploitation concession may be between 5,000 (500 for Guatemalans) and 25,000 hectares. Not more than 10 exploitation concessions may be held by one person or company, nor may one person or company hold more than 15 exploration and exploitation concessions or more than a total of 500,000 hectares under concession.

Drilling must be started within 6 months unless petroleum has been found, and it must continue with due diligence. If a discovery is made, production must begin within 3 years. Production may not be suspended for more than 3 years. Other obligations follow: (1) To mark the boundaries of the concession within 3 years, (2) to pay annual surface rental, royalties, and applicable taxes, (3) to nofity the Bureau of Mines and Hydrocarbons of the discovery of petroleum fields, (4) to advise the Bureau 90 days in advance of renouncement of rights, and (5) to fulfill the requirements of domestic consumption at the free market price before exporting petroleum or petroleum products.

Applications for exploitation concessions must meet the same general requirements as to information and documents as exploration applications. In addition, there must be an express statement concerning plans to commence drilling. The application fee for a concession is 1,000 quetzales, of which 75 percent is returnable if the concession is not granted.

A concessionaire may obtain nonexclusive rights to establish and operate installations to refine petroleum, and to construct and operate lateral and trunk lines for the transportation of petroleum or its derivatives.

## Fiscal Provisions

Every applicant for an exploration, exploitation, refining, or transportation right, or for an extension of these rights, must pay an initial quota of 500 quetzales for an exploration right and 1,000 quetzales for the others. If the right is not granted by the Government, 75 percent will be returned to the applicant.

Holders of exploration and exploitation concessions pay annual surface rentals at progressively increasing rates. If minimum financial committments are met with regard to exploration concessions, a 75-percent reduction of the annual surface tax is permitted, by deducting costs of exploration and development and royalties paid. In the case of exploitation concessions, the reduction of surface taxes is limited to 50 percent.

Concessionaires pay a royalty of 12-1/2 percent on petroleum produced, less amounts consumed in the field for the purpose of obtaining a more rapid, more efficient, or greater production. The royalty is to be calculated at the price of petroleum at the place of production in accordance with world market prices, and may be paid in cash or in kind. Four percent of the royalty is payable to the surface owner. If paid in kind, the crude is transported at Government expense or stored in concessionaire's facilities.

The law provides for an equal division of net profits between the state and petroleum companies. Concessionaires are subject to normal income tax and dividend taxes, plus an "additional tax" which is the difference between normal income and other direct taxes, and 50 percent of the concessionaire's net income after authorized deductions. Permissible deductions designed to permit the recovery of investments in exploration and development include costs of materials and service, amortization, a depletion allowance of 27 percent of gross income but not more than 50 percent of net income, losses, surface taxes and royalties, dry hole costs, interest on debts, wages and pensions, assets renounced or abandoned, and other items.

Losses may be carried over for 10 years. Provision is made for a reduction of the Government's share, when it is more than 50 percent of the net profits.

Holders of petroleum rights may import, free of customs duties, necessary materials and equipment which are not available in Guatemala.

# HAITI

## Controlling Statutes

Mineral development is governed by the Haitian Mining Law of March 21, 1968.[1] Development of "mines" and "quarries" is subject to Part I of this law. Development of hydrocarbon resources is governed by special legislation entitled "The Law of Liquid and Gaseous Hydrocarbons," found in Part II of the Mining Law.

## Administration

The agency responsible for administration of the mining law is the Service of Geology and Mines.[2] The duties of this agency are explicitly enumerated in the Mining Law and include the duty to assure proper execution of the Mining Law, to control mining exploitation, to study, counsel, and propose improvements to exploiters, to assure the reservation of minerals vital to the public welfare, to counsel and aid the Administrator General of Contributions in the collection of royalties, and to insure proper execution of mining operations concerning public safety and conservation.

The Service of Geology and Mines operates in conjunction with and in cooperation with the Secretary of State for Agriculture, Natural Resources and Rural Development, and the Bureau of Atomic Energy to insure efficiency and justice in mining activities in Haiti. Disputes arising from mining operations are settled by the civil tribunals of Haiti.

## Mining

Ownership of all subterranean elements is vested in the state. Mineral substances found in the subsoil of Haiti are classified as either "mines" or "quarries," depending on the nature of the substance.

Minerals included in the "mines" classification are coal and all other combustible materials except peat and hydrocarbons; alum, sulfates, and sodium; potassium salt; cobalt, nickel, chromium, magnesium, and tungsten; copper, zinc, lead; cerium and other rare-earth elements; columbium and tantalum, mercury, silver, gold, platinum; helium, radium, thorium, uranium, and other radioactive minerals; sulfur, selenium, and tellurium; arsenic, antimony, and bismuth; and all sources of mineral water.

All of the above minerals are "concessible substances" with the exception of substances used for atomic energy, the extraction of which is reserved to the State.

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[1] See also articles 22, 68, 93, 159, and 174 of the Haitian Constitution; Decree of December 20, 1943; Decree of January 11, 1936; Article 350 of the Labor Code; Law of August 25, 1966.

[2] For information, write Service de Geologie et des Mines, Department de l'Agriculture, des Ressources Naturelles and du Developpement Rural, Port-au-Prince, Haiti.

Any person may obtain mining permits or concessions in Haiti except the President of the Republic, members of the legislature or judiciary, directors of public service, military commanders, Government engineers, employees of the Service of Geology and Mines, and all others who by the nature of their employment represent the State in the regulation of mining operations. Foreign Governments are also excluded from participating in mining ventures. Any other person or company who can show technical and financial capability is eligible to apply for exploration or exploitation rights under the law.

## Exploration

Two types of exploration rights are available: ordinary exploration permits and exclusive exploration permits.

The ordinary exploration permit gives its holder the right to explore a specified area for specified substances. The permit is issued for a period of 2 years and may be renewed for another 2 years. The area granted for exploration may not exceed 10 kilometers in length or a total area of 10,000 hectares. A tax must be paid by the permittee for each permit and renewal, and, upon discovery of an exploitable deposit, the holder has a right to apply for an exploitation permit. Application for an ordinary permit must be made to the Service of Geology and Mines, which will send the application, with its own recommendation for acceptance or rejection, to the Secretary of State for final decision.

The exclusive prospecting permit gives its holder the exclusive right to explore a specified area for designated minerals. One person can hold several exclusive permits, and each permit may allow exploration for several substances. The exclusive permit is granted for a period of 1 year and may be renewed for a period of 2 years. Payment of a tax must be made with each application. Like the ordinary permit, the area of an exclusive permit is limited to a maximum of 10,000 hectares, with no boundary exceeding 10 kilometers. The holder of an exclusive permit may freely dispose of any minerals obtained in the course of his prospecting operations, and the discovery of an exploitable deposit entitles him to an exploitation permit if he can prove his financial and technical capability to continue his mining activities. To obtain an exclusive permit a person must apply to the Service of Geology and Mines, attaching to his application a general work program adapted to the physical characteristics of the area requested, a statement showing financial and technical capability, and a payment of a bond to secure the area against permanent damage.

Forfeiture of either an ordinary or exclusive permit may be accomplished by the holder himself or by the State if the holder fails to comply with the Mining Law or fails to fulfill his financial obligations.

## Exploitation

Two types of exploitation rights are available: mining concessions and exploitation permits.

A mining concession grants to its holder the exclusive right to exploit specified minerals, subject to certain royalty rights of the State and the surface owner. The concession is granted by presidential decree on the advice of the Secretary of State, and the rights and duties of the concessionaire are fixed in the concession agreement. The duration of the concession may not be more than 50 years. The area must form a square with its boundaries in N-S and E-W directions. No side may exceed 2,500 meters in length. The maximum total area is 625 hectares.

The holder of an exclusive prospecting permit can obtain a concession only within the area of his exclusive permit and only for those minerals specified in the permit. In addition to fixing the duration and area of the concession, the agreement will also determine what factories, machines, roads, and laboratories may be constructed, transportation and exportation methods, and all other rights and obligations of the concessionaire. The terms and duration of the concession agreement may be extended in accordance with the provisions therein.

Each application for a mining concession must be made to the Secretary of State and must include proof of an exploitable deposit, the type of mineral to be exploited and the area desired, a choice of domicile by the applicant, a deposit of a fixed sum of money as security, and a statement of financial and technical capability.

The exploitation permit is issued to prospectors for shorter periods of time than the mining concession, but as in the concession, the duties and obligations of the permittee are set out in the permit itself. The duration of a permit is 5 years, renewable for another 5-year period. The permit may be granted to a holder of an exclusive prospecting permit upon proof of the existence of the stated mineral substances and may be exchanged for a concession agreement upon a showing that circumstances so justify. Applicants must apply to the Secretary of State and must post bond. The permit, if granted, may be revoked, and the bond forfeited, if, without justification, work is discontinued for a period of 6 months or royalties are not paid for 1 year.

## Quarries

Quarries include slate, sandstone, gun flint, marble, granite, building stones, limestones, plaster, potters earth, pebbles, basalts, and any other mineral which is exploited by open-face extraction. Materials for use in ceramic industry, materials used to improve the culture of the land, other analogous substances (except phosphates, nitrates, alkalines, and other salts), and peat bogs are generally classified as quarries.

Although considered part of the public domain, quarries may be exploited by the surface owner upon a simple declaration to the Service of Geology and Mines. The State may also grant prospecting permits for 1 year, or exploitation permits for 10 years, to third persons if the substance sought to be exploited is of particular benefit to the State. Concession agreements may also be made, having a maximum duration of 30 years, the terms of which will be set forth in the concession agreement.

### Fiscal Provisions

Each holder of an ordinary or exclusive prospecting permit must pay a fee of 500 gourdes (1 gourde = US$0.20) with each application for a permit or renewal and must pay an annual surface tax ranging from 1 to 5 gourdes per hectare, depending upon the duration of the permit.

The holder of a mining concession must pay five taxes: an annual tax of 5,000 gourdes, an annual surface tax to be determined by the concession agreement, a royalty of at least 20 percent of the total sales, an income tax of 40 percent of profits, and a royalty of at least 10 percent of the royalty payable to the state to be paid to the surface owner.

An annual tax of 2,000 gourdes must be paid by the holder of an exploitation permit, as well as a royalty to the state and surface owner determined by the permit agreement.

## Petroleum

Ownership of gaseous and liquid hydrocarbons in Haiti is vested in the state. Part II of the Mining Law, entitled "The Law of Liquid or Gaseous Hydrocarbons," governs exploration and exploitation operations.

### Exploration

An exclusive exploration permit grants to its holder the exclusive right to prospect for hydrocarbons in a designated area and the right to dispose freely of any petroleum extracted during the exploration operations. The duration of the permit is 5 years, renewable for a period of 3 years, at the option of the Secretary of State. The area of the permit, decided by the Secretary of State, must form a square with its boundaries lying in N-S, E-W directions. The sides of the square cannot exceed 10 kilometers, and the total area cannot exceed 10,000 hectares. The rights and obligations of each permit holder will be set forth in the permit agreement.

An application for an exclusive exploration permit must show the applicant's technical and financial ability to carry on efficient exploratory operations. It must also contain a general work program showing the utility of that program for the desired geographical area.

### Exploitation

Only the holder of an exploitation concession can exploit liquid or gaseous hydrocarbons in Haiti. A concession may be granted only to the holder of a permit who can prove the existence of an exploitable deposit. The concession may be granted only within the area of that permit. The area of the concession, like the permit, must form a square, with boundaries lying in N-S, E-W directions. The total area may not exceed 625 hectares, and no side may be larger than 2,500 meters. The maximum duration of a concession is 30 years.

The concession sets forth its duration and area, rights and duties of the parties, special provisions for construction of canals to transport the produce, provisions for the building of refineries, and conditions upon which, at the end of the concession, it will cede to the State.

No right to explore or exploit hydrocarbons may be granted without the consent of the surface owner, and no wells may be bored within a radius of 50 meters from any dwelling or enclosure without the consent of the inhabitants.

To apply for an exploitation concession the applicant must show his technical and financial capability. Disputes over the capability of the applicant and the existence of exploitable deposits are decided by the Service of Geology and Mines.

A permit or concession holder may abandon his rights in whole or in part at any time. The State may terminate a concession if, without justification, it remains unexploited for a period of 1 year, or if the holder fails to comply with the regulations of the Mining Law.

## Fiscal Provisions

The holder of an exploration permit must post bond of 5,000 gourdes before beginning operations. He must also make an initial lump-sum payment for his permit of another 5,000 gourdes. An annual surface tax is levied, ranging from 1 to 2.50 gourdes per hectare depending upon the duration of the permit.

A concessionaire must post bond of 50,000 gourdes and pay an annual tax of 10,000 gourdes. In addition, the concession holder must pay an annual tax of from 5 to 20 gourdes per hectare depending on the duration of his concession, a royalty of 30 to 50 percent of the value of the extracted oil, an export tax, a tax on refined hydrocarbon products (for example, gas), and a royalty to the surface owner equaling 5 percent of that paid to the state.

# HONDURAS

## Controlling Statutes

The principal legislation governing mining in Honduras is the Mining Code of February 15, 1937 (Decree 64), as amended by Decree 119 of March 13, 1950. Development of petroleum resources is governed by the Petroleum Law, Legislative Decree 4 of October 25, 1962, and the regulations contained in Decree 21 of January 11, 1963.[1]

## Mining Law

Most mineral deposits are the property of the state. They are not subject to private appropriation, but the state may grant mining rights for exploration and exploitation of the subsoil. Mineral rights are considered real property and are separate from surface ownership.

Mines of sulfur, nitrates, iron, coal, asphalt, and manganese can be developed only under special contracts with the Government for a period not to exceed 20 years. The Code provides that precious stones and metals found in their natural state at the surface belong to the occupant. Gold, silver, and other mineral-bearing sands, located in rivers or sandbanks, may be freely exploited, provided they are located in unimproved lands; however, a mining claim must be acquired if they are to be worked by permanent installations. The state has reserved to itself deposits of uranium, uranium salts, thorium, and similar substances essential to the production of atomic energy.

Any person legally capable of owning real estate in Honduras may acquire mineral rights, except foreign governments or companies in which they have an interest, certain Honduran mining engineers who exercise administrative functions, and judges who settle mining disputes. Foreigners are entitled to the same civil rights as Hondurans; however, foreigners may not acquire mining concessions within 40 kilometers of a coastline or border.

### Exploration

No permission is required in order to prospect for minerals in unenclosed or uncultivated lands. Permission from the landowner or proper judicial authority is necessary to prospect on other lands.

The discoverer of a mineral deposit must make a declaration before a competent judge, and after publishing a notice in <u>La Gaceta</u> and making a survey, a title will be issued.

### Exploitation

Within the same mining field, no person may acquire more than three mining claims as discoverer, registrant, or concessionaire. A claim is a

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[1] For information, write Direccion General de Recoursos Naturales, Tegucigalpa, D. C., Honduras, C. A.

rectangular area bounded by vertical planes, and may have a maximum area of 5 hectares and a minimum area of 1 hectare. The Code authorizes the formation of mining zones of up to 200 hectares, for large-scale mining operations.

The owner of a mineral right is under the following obligations: (1) To begin mining operations within 5 years, (2) to employ on the average, six persons daily, (3) to submit an annual report containing technical, administrative, and financial data, (4) to have Hondurans constitute at least 75 percent of the work force, (5) to pay a moderate annual tax and royalty, and (6) to comply with the extensive health and safety provisions added to the Mining Code by Decree 119 of 1950.

Rights in a mining or processing concession will be terminated for the following causes: (1) Failure to pay taxes, (2) abandonment, and (3) failure to keep six miners working for a period of 6 months per year, or suspension of work for 200 days in a year.

## Fiscal Provisions

Owners of mining zones per claims must pay an annual tax of one lempira (1 lempira = US$0.50) per hectare. If, however, the mining and processing operations are combined, a higher tax is charged, which is determined by the type of processing employed.

The Code, as amended by Legislative Decree 3 of December 11, 1939, provides that a royalty of at least 5 percent of the net profits is payable to the State.

## Petroleum

Petroleum and other hydrocarbons are the property of the state. For the purposes of classification, the term petroleum as used in the law includes all natural mixtures of hydrocarbons that compose it, accompany it, or are derived from it. The petroleum industry is considered a public utility, and as such it has priority to the surface land and may expropriate land, provided compensation is paid to the landowner.

A permit or concession will be granted to any natural or juridical person, national or foreign, provided they have the requisite financial capacity and necessary technical skill to carry out petroleum operations. For foreign corporations to obtain a concession, they must be registered in the Registry of Commerce, establish a domicile in Tegucigalpa, and designate a Honduran citizen as their agent. Individuals must register in the Registry of Commerce and establish a domicile in Tegucigalpa. The following are prohibited from obtaining a petroleum concession either indirectly or directly: (1) Foreign governments or companies in which they have an interest, (2) certain Honduran Government officials, and (3) persons in default to the Government because of petroleum activities who have not posted sufficient bond.

## Reconnaissance Permits

Nonexclusive permits for reconnaissance are granted, subject to posting a 20,000-lempira liability bond and obtaining the permission of the landholder before entering private land.

## Exploration Concessions

A concession for exploration and subsequent exploitation on free land confers the exclusive right to explore a specified area for petroleum and the subsequent right to select one or more areas for exploitation. The maximum area of an exploration concession is 400,000 hectares, and the minimum allowable area is 5,000 hectares. In a zone comprising an offshore area, the maximum allowable area to any one natural or juridical person is 1,000,000 hectares and the minimum area is 10,000 hectares.

The duration for the exploration concession is 6 years with two renewal periods up to 2 years each.

The holder of an exploration concession is entitled to the free use of timber and water from public lands, unless the lands are subject to conservation restrictions.

The holder of an exploration concession is under the following obligations: (1) To commence exploration 180 days after the concession is granted and continue work with due diligence, (2) to notify the Department of Natural Resources within 15 days if any commercially exploitable petroleum is discovered, (3) to pay a progressively increasing surface tax after the first year, and (4) to make minimum annual investments in exploration on a graduated scale (0.50 lempira per hectare the second year up to 1.50 lempiras per hectare during the ninth and tenth years).

Discovery confers upon the holder of an exploration concession the right to subsequent exploitation in an area not exceeding 50 percent of that granted originally for exploration.

## Exploitation Concessions

The exploitation concession confers upon the holder the right to carry out all activities related to the exploitation of petroleum. The duration of an exploitation concession is 40 years, plus one renewal for 20 years.

The obligations of the holder are as follows: (1) To commence work within 6 months of the publication of title, and to continue with due diligence, (2) to nofity the Department of Natural Resources within 15 days if any commercially exploitable petroleum is discovered, (3) to produce petroleum at a rate required to meet the needs of the internal market and export possibilities, (4) to store the petroleum belonging to the State for a period of 30 days, at which time the State has the right to exercise its option to receive either the petroleum or value of the royalty in money, and (5) to pay all surface taxes and royalties.

Upon application to the Department of Natural Resources, direct concessions for exploitation may be granted. These concessions may not exceed 25,000 hectares nor be less than 1,000 hectares. There is no limit on the number of direct concessions one may apply for, provided that the total combined area is not more than 200,000 hectares. Direct concessions in the offshore areas are subject to special regulations, and the maximum area which may be granted offshore is 500,000 hectares.

Upon the termination of a concession all works and installations revert to the State without reimbursement. Termination of a concession may be brought about for several reasons: (1) For failure to meet the minimum investment requirements, (2) for failure to meet the financial obligations of the law, (3) by surrender, (4) by abandonment, which is defined as complete inactivity for a period of 1 year, and (5) for failure to cooperate with Government officials in allowing inspections and for failure to submit the required administrative and technical reports.

## Transportation, Processing and Refining Concessions

In general the law permits the holder of the concession to carry out any activities necessary for transporting the petroleum through pipelines. Because transportation is considered a public service, the holder is under an obligation to transport the petroleum of third parties. The duration of an independent transportation concession is for 40 years, whereas a transportation concession deriving from an exploitation concession is of the same duration as the original concession.

The law authorizes granting concessions for processing or refining, either by persons who wish to operate as an independent industry, even if there is no petroleum production in the country, or by persons who are holders of an exploitation concession. Concession holders have the right to process and refine the products of other concessionaires and, in addition, are entitled to the right of transportation. The holders of this concession are under the following obligations: (1) To process and refine petroleum for third parties, subject to agreements, and (2) to begin operations the first year the concession is in effect. The duration of an independent concession is for 40 years, but if it derives from an exploitation concession it is of the same duration as the original concession.

## Fiscal Provisions

To maintain an exploration concession the holder must pay after the first year an annual surface tax. The tax, computed on a graduated basis, ranges from 0.25 lempira per hectare the second year to 0.75 lempira per hectare during the ninth and tenth years. The amount invested for exploration may be deducted from the surface tax up to 85 percent the second and third years and up to 75 percent in subsequent years.

In addition to the annual surface tax, the holder of an exploitation concession must pay an initial tax of 2,000 lempiras. The exploitation surface tax is computed on a graduated basis, ranging from 3.00 to 9.00 lempiras per hectare. The following deductions may be made in the computation of

exploitation surface taxes: (1) The amount of royalty paid by the concessionaire for the year and (2) if there is no production, 75 percent of the amount invested by the concessionaire during the year in exploration activities.

At the end of every quarterly period the concession holder is subject to payment of a royalty of 12.5 percent in kind or cash, at the option of the State. For concessions located in the continental and insular shelf the royalty is fixed at 10.5 percent.

The holders of petroleum concessions are subject to the normal income tax, plus an additional tax if the total surface taxes, royalties, and normal income taxes paid to the Government do not equal 50 percent of the net profits. The petroleum law provides that investments during the exploration period are to be amortized in equal installments over the life of the exploration concession. In determining the taxable profits payable by the holder of an exploitation concession, a deduction of a depletion factor is allowed, amounting to 25 percent of the gross value of production, computed after payment of royalties, with the limitation that this deduction shall in no case exceed 50 percent of the net profits for the year concerned from activities connected with production, before deducting the depletion factor.

Net losses, excluding the amount of surface taxes and royalties, may be deducted over a 10-year period.

Holders of petroleum rights may import, free of customs and duties, all necessary materials and equipment for petroleum operations that are not produced satisfactorily in Honduras. Exports of petroleum and of products obtained from refineries located in the country are not subject to custom duties.

# JAMAICA

## Controlling Statutes

Jamaica gained independence in 1962 and is a member of the British Commonwealth.

The principal mining legislation in Jamaica is the Mining Law No. 41 of 1947 (Chapter 253 of the Revised Edition (1953) of the Laws of Jamaica). The Mining Law, which was enacted after the Minerals (Vesting) Law No. 38 of 1947, now Chapter 251, is supplemented by the Mining Regulations of 1947 and the Mining (Amendment) Regulations. The mining law is administered by the Commissioner of Mines.[1]

Development of petroleum resources is governed by the Petroleum (Production) Law (Chapter 292 of the Revised Edition (1953) of the Laws of Jamaica). Recent amendments include Law 10 of 1955, Law 47 of 1956, Law 18 of 1957, Law 59 of 1960, and supplementary Rules and Regulations made under the authority of the above laws.[2]

## Mining Law

Under the 1947 Minerals (Vesting) Law, all natural mineral resources are vested in and subject to the control of the Crown. For classification purposes, the term "minerals" does not include mineral oils, gypsum, phosphates, or construction materials such as sand, clay, and limestone.

The Minister may, by notice in the Gazette, either declare an area closed and prohibit all prospecting and mining activities or prohibit prospecting and mining for specified minerals. Law 17 of 1947 specifically prohibits the prospecting or mining of radioactive minerals in Jamaica except by license issued by the Minister.

## Prospecting Permit

Upon application the Commissioner is empowered to grant a nontransferable prospecting permit that entitles the holder to prospect anywhere. Minerals obtained in the course of prospecting are to be considered the property of the Crown and may not be retained or disposed of without prior permission from the Commissioner. The permit is valid for 1 year, and is renewable for additional 1-year periods. It qualifies the holder to mark out an area and apply for an exclusive prospecting license or a mining lease. A corporation may hold a prospecting permit only through the individual name of a responsible agent.

### Exclusive Prospecting License

An exclusive prospecting license may be granted for a specified mineral by the Minister to applicants with sufficient capital resources to fulfill

[1] For information, write Department of Mines, Hope, Kingston 6, Jamaica.

[2] Petroleum (Production) Regulations of 1950 as amended by the Petroleum (Production) (Amendment) Regulations.

their obligations. The area of a license is restricted to 8 square miles, but licenses may be grouped to cover 24 square miles. A license is valid for 1 year and may be renewed by the Minister. Although it is transferable only with the Minister's consent, the license may be surrendered at any time. An exclusive license obligates the holder to conduct bona fide prospecting operations. Every license holder who is not a resident of Jamaica, whether individual or juridical, must be represented by an attorney resident in the Island with full powers to represent such holder in all matters relating to the license. The Minister may also issue a special exclusive prospecting license for any area and period, and under any terms he may deem desirable.

### Mining Lease

Minerals may be exploited only under a mining lease. Applications for such leases are made to the Minister through the Commissioner. The applicant, in addition to marking out the area over which he desires a lease, may be required to deposit with the Commissioner sufficient amounts of capital to insure efficient operations and to indemnify landowners for any possible damages. The lease granted for a specified mineral may only be transferred with the Minister's consent. Upon the discovery of new minerals it is within the discretion of the Minister to permit the exploitation of additional minerals. The initial term of a lease is for a period not in excess of 25 years, subject to one renewal of the same duration. A lessee obtains an exclusive right to mine and market the specified minerals, provided bona fide mining operations are begun within 6 months and the operational regulations established by the Commissioner are met. Each lessee must pay royalties to the Commissioner, and no person may export minerals unless he holds a certificate stating that the royalties have been paid.

## Petroleum

Ownership of petroleum resources is vested in Her Majesty, and the Government has the exclusive right to grant exploration and prospecting licenses and oil mining leases. The Government may authorize exploitation whether the land involved is Crown land or in private ownership. The following restrictions are placed on foreign corporations: (1) The corporation must have a duly authorized agent resident in the Island, (2) the corporation upon application for a license or lease must include the names, nationalities, and other information about its directors and principal shareholders, and (3) petroleum rights in Jamaica will not be granted to any foreign person or corporation whose country does not grant reciprocal rights to British subjects.

### Oil Exploration License

The holder of an oil exploration license is entitled to explore and search for petroleum in the area specified in the license and to drill to a depth not exceeding 500 feet. The area of a license may not be less than 8 square miles. The initial duration of a license is 2 years, subject to renewal for a 1-year period. The exploration license requires that the licensee with due diligence carry out such geological and geophysical work as may be necessary to determine the structure of the lands. The license fee is £50 (1£ = US$2.40) for every 1,000 square miles or part thereof, with a

minimum fee of £100 and a maximum fee of £1,000. On or before the expiration of an oil exploration license or in lieu of an oil exploration license, the licensee can obtain an oil prospecting license.

### Oil Prospecting License

An oil prospecting license gives the holder the sole right to prospect and drill for petroleum on the land covered by the license and to dispose of any petroleum produced by the prospecting work. The license may not cover an area of more than 200 square miles nor be less than 8 square miles. The regulations provide that the area for which the license is granted must be compact and limited by well-marked permanent physical boundaries or bounded by straight lines. The license is valid for a period of 4 years, and may be renewed for 1 year. The holder of an oil prospecting license is required to indemnify third parties for any damage or injury. No specific rental or fees are prescribed in the law or the regulations; these amounts are negotiated by the Government when granting the license. The oil prospecting license provides that on or before the expiration of the license, the licensee has the right to obtain an oil mining lease. The Government is not required to grant a lease for any area exceeding in the aggregate 50 percent of the original area covered by the license.

### Oil Mining Lease

An oil mining lease may be granted for an area not greater than 100 square miles nor less than 4 square miles. A comprehensive oil mining lease may be granted with respect to two or more separate areas situated on the same geological structure, or may cover a group of geologically similar and related structures, provided the sum of such areas does not exceed 100 square miles. The initial term of a lease is 30 years, renewable once for an additional 30 years. Before obtaining a lease the applicant is required to make a topographical survey of the lands, and in the case of submarine lands the Government may require the applicant to make a hydrographic survey.

The amounts of yearly rental and royalties are determined when the licenses and leases are being negotiated with the Government. As an incentive for investment the Customs Tariff (Amendment No. 2) Resolution of 1955 provides for import duty concessions to be granted on certain machinery, equipment, and stores imported for use in connection with the petroleum industry.

# NICARAGUA

## Controlling Statutes

The principal mineral legislation in Nicaragua is the 1958 General Law on the Exploitation of Natural Resources, which is supplemented by the Special Laws governing mining and petroleum. The Special Law on the Exploration and Exploitation of Mines and Quarries, which was enacted by Decree 1067 of March 20, 1965, has replaced the Mining Code of March 19, 1906, but preserved all rights granted prior to the decree. The petroleum industry is governed by the Special Law on the Exploration and Exploitation of Petroleum enacted by Decree 372 of December 3, 1958.

## Administration

The 1965 legislation on mining provides for the creation of the National Mining Commission composed of the Minister of Economy, the Minister of Finance, the President of the Central Bank, the General Manager of the National Development Institute, a representative of the minority party in the National Congress, and one representative of the mining enterprises. The National Mining Commission has the following functions: (1) To determine the minimum investment required of the holder of an exploration concession, (2) to determine the minimum annual amount of work required of the holder of an exploitation concession, (3) to determine the ad valorem tax, (4) to establish the amount of royalty or participation of the State in the cases of quarries which it owns, and (5) to serve as an advisor to the Ministry of Economy on all matters relating to the exploration and exploitation of mines and quarries.

The Office of the Director General of Natural Resources is charged with the supervision of the day-to-day technical and administrative aspects of the operations relating to the exploration and exploitation of mines and quarries.[1]

## Mining Law

The state is the owner of all mineral riches of the subsoil with the exception of substances generally used for construction and ornamentation. These mineral substances are placed in the category of quarries and belong to the surface owner. All other deposits, including those of precious stones, if not defined as quarries, are considered to be mines.

Uranium, thorium, lithium, and their derivatives, along with certain other mineral substances, may in the interests of national defense be declared to be "of temporary strategic interest." In that case, according to Article 8, the granting of exploration concessions may be suspended, survey permits prohibited, and concessions for exploration and exploitation submitted temporarily to special rule.

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[1] For information, write Servicio Geologico National, Ministerio de Economia. Apartado Postal No. 1347, Managua, D. N.

The Ministry of Economy may set aside specific zones, if the interests of national security require it, as either permanent or temporary national reserves. These reserves are excluded from the provisions of the General and Special Law; however, any concession previously in force in a reserve zone retains its validity and all rights are maintained.

Any person or corporation, national or foreign, may be granted a mineral concession, with the exception of foreign governments or companies in which they have an interest, certain public officials of Nicaragua, and persons who are considered tax delinquent. In certain cases foreign corporations seeking to obtain a mining concession may be required to establish a local company under Nicaraguan law. In the case of a concession already granted to a foreign individual or company, the state may require them to adjust their accounting system to that applicable to Nicaraguan nationals.

### Reconnaissance

A reconnaissance permit is granted free of charge and entitles the holder to undertake any surface investigations using any geophysical methods necessary for the purpose of discovering indications of mineral substances.

### Exploration Concession

The holder of an exploration concession is granted the exclusive right to conduct all operations necessary to determine the existence of a mineral deposit within the specified area of the concession.

The minimum area of a concession is 100 square kilometers, and the maximum area is 5,000 square kilometers. Depending on the area involved, concessions may be granted for periods ranging from 2 to 5 years, with a right of renewal for 2 more years. If a concession is renewed, one-half the initial area, selected by the concessionaire, reverts to the State.

The concessionaire has the right to dispose of any materials extracted in connection with the exploration, and upon discovery of a commercial deposit he has the right to obtain an exploitation concession.

If the exploration concession is granted in privately owned land, the surface owner has 3 months within which to exercise his right to participate in the exploration.

The surface owner's right to participation is limited to 10 percent of the investment made by the concessionaire and must be in cash. When the owner of the land participates in exploration, he may participate to the same or a lesser extent in the exploitation.

### Exploitation

Exploitation concessions grant for a specified period of time the exclusive right to extract, sell, and export those natural resources indicated in the concession. Two classes of exploitation concessions may be granted. Long-term concessions may be granted for periods ranging from 30 to 50 years,

renewable once for a period of 20 years. Short-term concessions for exploitation may be granted for an initial period of 10 years, renewable two consecutive times for 5 years each time. A short-term concession may be converted into a long-term concession if it is demonstrated that this longer period of time is needed for exploitation. Both classes must be in the form of a rectangle of 5 to 20 square kilometers. No one, directly or indirectly, may acquire concessions which in total exceed 120 square kilometers.

A concessionaire is authorized to extract mineral substances allied with substances for which the concession was granted by applying for an extension to cover the additional substances. In certain cases the State may require that allied substances or others found in commercial quantities be included if exploitation is economically possible. Concession holders are further entitled to engage in the following activities: (1) To establish, without a license, a processing plant, (2) to utilize the timber and water, found on the concession or adjacent land, in a reasonable fashion, and (3) to engage in any of the basic work necessary to carry out the various operations required for exploitation, particularly the transportation of provisions, materials, equipment, and extracted substances.

A concessionaire is obligated to undertake a minimum amount of work and to make a minimum annual investment based on the size and quality of the deposit. Failure to meet these requirements or to pay taxes may result in cancellation of the concession. Additionally, the holder is required (1) to conform to all safety regulations, (2) to periodically submit maps as well as technical and financial reports, and (3) to supply the needs of the domestic market, at world market prices, whenever the state declares it to be in the national interest.

Applications for concessions must be made to the Bureau of National Resources of the Ministry of Economy, following the steps indicated in the General Law on Natural Resources. Before applying for a concession for exploration or exploitation, an applicant must deposit with the Central Bank a "deposit of costs," which may not be less than 500 cordobas nor more than 1,000 cordobas, the amount being fixed in each case by the Bureau of Natural Resources (1 cordoba = US$0.143). Holders of a concession must also make a "deposit of guaranty," ranging from 1,000 to 70,000 cordobas, which may be made by means of a performance bond.

The holder of an exploitation concession may renounce it any time, totally or partially; in the latter case, approval by the Ministry of Economy is required.

## Fiscal Provisions

Holders of concessions are required to pay the following taxes:

1. Fixed fees for granting concessions, ranging from 7,000 cordobas for an exploration concession to 35,000 cordobas for a long-term exploitation concession.

2. A surface tax computed on a graduated basis, imposed only on exploitation concessions, ranging from 280 cordobas per square kilometer in the first year to 1,400 cordobas per square kilometer after the eighth year.

3. An ad valorem tax which is variable and proportional to the value of the substances extracted based upon the value at the site of extraction less freight costs to destination. The amount of the ad valorem tax is 5 percent but the National Mining Commission may reduce it to 0.4 percent or raise it to 10 percent.

4. 30 percent of the profits to the state, as the share belonging to the state.

This tax replaces the income tax, and both the surface tax and ad valorem tax are deductible from the "share of the state." For the purpose of determining the state's share, the following may be deducted in computation of net income: (1) Cost of materials used in mining and processing operations, (2) percentage for the depreciation of the capital goods excluding mineral reserves of the subsoil, (3) 15 percent of the gross value of the products extracted for the purpose of depletion, but no more than 50 percent of the net profits computed for the respective period, (4) the costs of exploration and the intangible costs of evaluation of the minerals, (5) expense of administration and other general expenses, (6) nonrecoverable value of capital goods abandoned during the year, and (7) the net losses from the previous years.

The costs of the concessionaire during the exploration period may either be considered as investments and charged against the balance sheet and amortized in subsequent periods established by the National Mining Commission, or they may be considered losses due to abandonment. During the exploitation period the intangible costs of evaluation may either be charged against the balance sheet or deducted as an operating expense during the taxable year.

The state has the option of participation in the capital of the concessionaire, for any one of the following reasons: (1) As compensation for the utilization by the exploiter of discoveries of mineral substances made by the state, (2) as a regular shareholder, if the State contributed capital, and (3) as compensation for the exploitation of a deposit considered by the state to be of national importance, in which case the state may demand shares representing not more than 10 percent of the necessary initial capital.

Holders of concessions may import, free of all customs and taxes, all necessary materials and equipment for mining operations. They will also enjoy an exemption on the payment of taxes on the capital invested in the enterprise.

## Petroleum

Decree 372 of December 3, 1958, fixes certain rules under which the contracting parties or concessionaires can enjoy exclusive rights over certain zones for exploration and exploitation. For the purposes of the 1958 law, the term "petroleum" includes all natural mixtures of hydrocarbons and derivatives of hydrocarbons, such as natural gas, crude petroleum, asphalt, and oil-bearing schists, but excludes coal.

The law establishes four zones: Pacific, Central, Atlantic, and Continental Shelf.

The state owns all petroleum resources, and permits are required for all stages of petroleum operations. Reconnaissance may be freely engaged in under special permits issued without charge.

### Exploration Concessions

The term of an exploration concession is generally 3 years, with a right to renewal for 3 years. Maximum concession areas are 150,000 hectares in the Pacific zone, 300,000 hectares in the Central zone, 200,000 hectares in the Atlantic zone, and in the Continental Shelf zone, 300,000 and 400,000 hectares on the Pacific and Atlantic sides, respectively. No more than three times the maximum concession area may be held by one concessionaire in a single zone. Minimum annual exploration expenditures vary with the zones, ranging from US$0.15 to US$0.40 per hectare.

### Exploitation Concession

An exploration concession may be converted into an exploitation concession following the discovery of petroleum in commercially exploitable quantities during the term of the exploration concession. The duration of a concession is for 40 years and is renewable for 20 years. Exploitation concessions may not exceed either 50 percent of the exploration area (the concessionaire is required to return an amount equal in area to the exploitation concession to the Government) or a maximum of 25,000 hectares. Maximum exploitation holdings per concessionaire range from 225,000 hectares in the Pacific zone to 600,000 hectares in the Atlantic Continental Shelf zone.

In addition to those rights pertaining to an exploration concession, the holder of an exploitation concession has the right to obtain a concession for the refining and transportation of petroleum.

The concessionaire is under the following obligations: (1) To drill one or more wells with a total depth of 5,000 meters for each 100,000 hectares of the exploitation concession during the first 7 years, (2) to drill two or more wells with a total depth of 10,000 meters for each 20,000 hectares during the following 8 years, (3) to provide education and specialized training for Nicaraguan employees, numbering not less than 5 percent of foreign personnel employed, and (4) to provide the Ministry of Economy with periodic technical, geological, and financial reports.

Every application for an exploitation concession, in addition to the required forms, must be accompanied by maps and aerial photographic composites of the terrain of the respective concession.

An exploitation concessionaire has a right to obtain 40-year refining and transportation concessions subject to the requirement that compatible oils belonging to third parties or to the Government be transported on request. Operations must begin within 1 year. Payments received for the transportation

of oil belonging to a third party are subject to a 2-percent tax. Refiners must pay a tax that is equivalent to 50 percent of the tax on comparable imports.

## Fiscal Provisions

Concessionaires assume the following financial obligations:

1. Guarantee deposit.--The General Law on the Exploitation of Natural Resources requires that there be a guarantee deposit in the case of all petroleum concession or license holders. The amount of guarantee deposit for an exploration concession ranges from US$0.15 per hectare in the Central zone to US$0.40 per hectare in the Pacific zone. In the case of an exploitation concession the guarantee deposit is twice that required for an exploration concession. For licenses for the refining or transportation of petroleum, the amount of deposit is fixed by the Ministry of Economy, taking into account the capacity and value of the installations in each case.

2. Surface tax.--Exploration concessionaires must pay an annual surface tax ranging from US$0.02 per hectare per year in the Central zone to US$0.25 per hectare per year in the Pacific zone. Surface exploitation taxes start at US$0.05 to US$0.15 per hectare per year, depending on zone, and reach a maximum of US$1.00 per hectare in the Pacific zone by the 16th year. The tax decreases to US$0.05 per hectare for all zones in the last 10 years of the concession. An initial exploitation tax amounts to US$0.50 per hectare in the Pacific zone and to US$0.20, US$0.30, and US$0.25 in the Central, Atlantic, and Continental Shelf zones, respectively.

3. Royalties.--The royalty rate varies with the rate of production. A royalty of 10 percent is due on production of less than 5,000 barrels per day, and 16-2/3 percent on production of more than 15,000 barrels per day. The royalty is payable in cash or in kind at the option of the state. In computation of the royalty the following items are deductible: (1) Petroleum used by the concession holder in his own operations, and (2) petroleum injected into a deposit for the purpose of obtaining more efficient production. An additional royalty of 1 percent is payable to the owner of the land, or to the state if the concessionaire is also the owner of the land.

4. Income tax.--The petroleum industry is also subject to the general income tax; the maximum present rate is 18 percent. In addition to deductions authorized by the general tax law, the following special deductions may be taken by holders of petroleum concessions: (1) Cost of materials, (2) amortization, (3) depletion allowance of 27.5 percent of production less royalties, up to 50 percent of net after all deductions except depletion allowance, (4) annual exploitation tax, (5) exploration costs, (6) intangible drilling costs and dry holes, (7) costs of administration and similar expenses, (8) value of abandoned equipment, and (9) losses in previous years.

The sum of annual exploitation tax, royalty, and income tax may not exceed 50 percent of the concessionaire's net income in any year, before authorized deductions.

5. Customs.--The holders of petroleum concessions or licenses are entitled to full exemption from custom import taxes on materials or equipment specified in the General Law on Exploitation of Natural Resources for 10 years. They are also exempt for the same period from taxes imposed on the capital invested in their enterprises.

# PANAMA

## Controlling Statutes

The principal legislation governing both mining and petroleum operations in the Republic of Panama is the Code of Mineral Resources, Decree Law No. 23 of August 22, 1963. The term "mineral" as used throughout the Code means any chemical element or compound occurring naturally as a product of a geological and biological process, including any hydrocarbon compounds occurring naturally in a liquid, solid, or gaseous state and any artificial deposit derived from such element or compound.

## Administration

The Code creates the Mineral Resources Administration, under the direction of the Ministry of Agriculture, Commerce and Industry, for the purpose of carrying out the technical and administrative duties under the Code.[1]

To handle any disputes that might arise, the Code provides for a conciliation procedure under the direction of the Executive Director of the Mineral Resources Administration. After allowing the interested parties to state their points of view, the Director decides the disputed matter by issuing a Resolution.

At this point in the conciliation procedure the parties may file an appeal from the Executive Director's decision to the Executive Organ. Another hearing shall be held under the Minister, or a public official appointed by him who has no connection with the Mineral Resources Administration. After the report of this second hearing is submitted, the Executive Organ shall decide the matter by passing a Resolution.

## Mining and Petroleum

The mineral deposits are the property of the state, and while not subject to private appropriation, they may be "granted in usufruct" pursuant to the form and conditions set forth in the Constitution and the Code. All minerals with the exception of hidden treasuries and tombs, common sand and gravel, clayey calcareous and fertilizing materials, and saltworks and mineral springs are subject to exploitation under the Code. Concessions are granted according to a mineral classification related to the depth (measured vertically from the surface) at which the minerals are found. With the exception of class F, a mineral which may belong in more than one class should be placed in the category corresponding to the higher letter of the alphabet. The classes are--

Class A: Minerals at a depth not greater than 20 meters and which are used in construction or as fertilizers.

Class B: Minerals at a depth of not more than 50 meters, with the exception of minerals in veins or lodes.

[1] For information, write Administracion de Recursos Minerales, Ministerio de Comercio e Industrias, Apartado Postal 8515, Panama 5, Panama.

Class C: Minerals at any depth in veins or lodes.

Class D: Minerals at a depth of not more than 300 meters.

Class E: Minerals at a depth of more than 300 meters.

Class F: Minerals specifically identified as reserve minerals.

The Code provides for the establishment of Reserve Areas which are either expressly designated as such or which have become Reserve Areas because they have been abandoned or returned to the State by virtue of the expiration or termination of a mineral concession.

In addition to Reserve Areas the Executive Organ may designate certain minerals as Reserve Minerals. While concessions for these minerals are granted in the normal fashion, they are subject to special provisions such as extraction quotas.

With the exception of foreign governments or companies in which they have an interest, certain public officials in Panama, and persons in default with the National Treasury, any person or corporation, national or foreign may be granted a mineral concession, provided their technical and financial qualifications have been verified. Foreigners and foreign corporations must keep an attorney-in-fact in Panama.

Certain of the Code provisions which apply generally to all mineral concessions are (1) preference in hiring must be given to nationals with equal qualifications to the extent that foreign citizens may not exceed 25 percent of all personnel employed, and their salaries may not exceed 25 percent of the total salaries paid (this requirement does not apply to exploration concessions), (2) the state may demand that a share of the minerals be delivered to it, for internal consumption purposes, with the concessionaire determining the price in agreement with world market prices, (3) concessionaires may acquire limited easements to the surface, including timber rights and use of building stones, as well as limited water rights, (4) where the owner of private property objects to the use of his land for mineral purposes, the state may expropriate such property with the concessionaire paying the cost of the expropriation, (5) before a concession may be granted the holder must pay a filing fee and post an acceptable guarantee bond to cover possible damage or injury to third parties, and (6) the privileges, terms or obligations established in the Code and in force when the mineral concession is granted, which become incorporated into the concession contract, may not be adversely affected by subsequent Government regulations. This principle was modified by Cabinet Decree No. 264, according to which the contract does not have to incorporate all the clauses of the Code.

Two basic types of exploration rights are available: prospecting permits and exploration concessions.

## Prospecting Permit

The prospecting permit is a nonexclusive right to carry out preliminary geological surveys for minerals of one or more classes within specified zones. There appears to be no set limit either to the number of permits which may be held or to the area which the permit covers. The only limitation appearing in the Code is that the area covered by the prospecting permit be limited to the Province, District, or areas included in the original petition for the permit. These permits are granted by Resolution of the Mineral Resources Administration and are initially good for 6 years.

## Exploration

The exploration concession normally confers exclusive rights with regard to all minerals within one particular class. The activities authorized by the concession are (1) to carry out, in a nonexclusive manner, preliminary geological surveys, (2) to carry out, in an exclusive manner, all other required operations to find minerals covered by the concession, and (3) to obtain, in an exclusive manner, an extraction concession once minerals are found in commercial quantities.

The holder of an exploration concession is under the following obligations: (1) To make available to the public the highways, airports, channels, and other similar means of access built by him, (2) to begin preliminary geological reconnaissance within 90 days, (3) to have started mineral exploration within 1 year, (4) to commence preextractive operations within specified time periods, (5) to begin extractive operations once the mineral is discovered in commercial quantities and to have continued such operations with due diligence, (6) to notify the Mineral Resources Administration of minerals found in commercial quantities, and (7) to make annual reports of a fiscal, technical, and administrative nature to the Mineral Resources Administration.

The initial period of each exploration concession and the maximum number of hectares that may be held by one concessionaire, corresponding to each class of minerals, are as follows:

| Class of minerals | Period (years) | Surface (hectares) |
|---|---|---|
| A | 3 | 10,000 |
| B | 5 | 100,000 |
| C | 5 | 100,000 |
| D | 6 | 250,000 |
| E | 7 | 500,000 |
| F | 7 | 100,000 |

Exploration concessions may be extended twice for a period of 2 years each, provided the concessionaire either returns 15 percent of each zone held or accepts certain other obligations or conditions. The area of each zone included within an exploration concession, or the total area if it comprises only one zone, shall not be smaller than 100 hectares for class A minerals and 1,000 hectares, for minerals of other classes. In addition to certain definite limitations on the shape of the concessions, no concessionaire may

simultaneously keep an exploration concession and extraction concession comprising the same class of minerals within the same zone.

Unlike the prospecting permit, the exploration concession is granted by means of a contract entered into by the individual and the State. The applicant in filing his petition for the concession must include specified information required by the Code and further designate the concession area by means of a map. When simultaneous applications have been filed, and the parties involved cannot make the necessary adjustments between themselves, the granting of the concession will be decided by competitive bidding.

Upon the discovery of minerals in a zone covered by the exploration concession, the holder of the concession is by right entitled to an extraction concession.

## Extraction

The extraction concession confers exclusive rights with regard to specific minerals within one class of minerals in particular. The activities authorized by the concession are (1) to carry out, in a nonexclusive manner, preliminary geological surveys within the concession area for minerals listed in the concession, (2) to carry out, in an exclusive manner, all other necessary operations to extract the minerals covered by the concession, and (3) to obtain concessions that cover operations of transportation and processing with regard to the extracted minerals.

The holder of an extraction concession is obligated: (1) To make available to the public the highways, airports, channels, and similar service facilities built by him, (2) to begin preextracting operations, if the mineral has not been found in commercial quantities, in at least one zone within 1 year and in the remaining zones within 2 years, (3) to make annual reports of a fiscal, technical, and administrative nature to the Mineral Resources Administration, and (4) if minerals are found in commercial quantities, the holder, while under the obligation to begin extracting operations within 1 year, may be exempted for a period of 3 years from beginning operations in the other zones.

The initial period of each extraction concession and the maximum number of hectares that may be held by one concessionaire, corresponding to each class of minerals, are as follows:

| Class of minerals | Period (years) | Surface (hectares) |
|---|---|---|
| A | 10 | 2,000 |
| B | 15 | 40,000 |
| C | 20 | 40,000 |
| D | 20 | 100,000 |
| E | 25 | 200,000 |
| F | 25 | 50,000 |

While the extraction concession is in effect, no increases may be made to the total area of the concession, or to the total number of minerals

covered by the concession. The duration of the concession may be extended three times, the first one for a period of 10 years and the second and third ones for periods of 5 years each, provided that the concessionaire returns 20 percent of each zone held or accepts certain other obligations.

The area of each zone included within an extraction concession, or the total zone if it comprises only one zone, shall not be smaller than 50 hectares for class A minerals and 500 hectares for minerals of other classes. While there are definite limits on the shape of the concession, the boundaries must be straight lines oriented N-S or E-W.

The holder of an exploration concession who applies for an extraction concession is by right granted such a concession. Other applicants for an extraction concession must include in their petition an offer of a premium payable to the Republic. Petitions must be accompanied by a special map and contain much of the same specified information as was required for an exploration concession. Again, as was the case with exploration concessions, when simultaneous applications have been filed, the granting of the concession will be by competitive bidding.

## Transportation and Processing

The holders of transportation and processing concessions are authorized to undertake all activities related to the transportation and processing of the minerals enumerated in the concession. The holder of a transportation concession is under the obligation to transport the minerals of third parties, up to the amount of the capacity of his installation, after deducting the quantities of minerals extracted by the concessionaire that he must transport. The Executive Organ shall determine the rates to be charged by the persons holding a transportation concession, and these rates are to be set forth in a tariff.

It is not necessary that the applicant be a titleholder of a mineral concession in order to obtain a transportation or processing concession. However, should the applicant be a titleholder, a transportation and processing concession must be granted for the minerals within his concession. The initial duration of the concession is for 25 years with three extensions being granted; the first one for a period of 10 years, and the second and third ones for a period of 5 years each.

## Surface Tax and Royalties

The Code provides for both royalties and a graduated surface tax to be paid per hectare for both exploration and extraction concessions. A deduction of a maximum 75 percent of the surface taxes will be allowed for actual exploration work performed in the concession.

The payment of royalties shall be in cash or in kind at the discretion of the Executive Organ. The landowner on whose land the mineral deposit is found shall have a right to 5 percent of the amount of said royalty, in the proportion corresponding to his territory.

In the tables below, the surface taxes are expressed in balboas (1 balboa = US$1.00) per hectare per year, and the royalty as a percentage of the gross negotiable production.

I. EXPLORATION CONCESSIONS

| Class | Surface Tax: First 3 years | Surface Tax: 4th-6th years | Surface Tax: 7th and following years | Royalty, percent |
|---|---|---|---|---|
| A | 0.05 | 0.10 | 0.15 | 2 |
| B | .10 | .15 | .20 | 5 |
| C | .15 | .20 | .25 | 8 |
| D | .20 | .25 | .30 | 10 |
| E | .30 | .40 | .50 | 14 |
| F | .25 | .30 | .35 | 15 |

II. EXTRACTION CONCESSIONS

| Class | Surface Tax: First 5 years | Surface Tax: 6th-10th years | Surface Tax: 11th and following years | Royalty, percent |
|---|---|---|---|---|
| A | 0.15 | 0.25 | 0.20 | 2-1/2 |
| B | .20 | .30 | .40 | 6 |
| C | .30 | .45 | .60 | 9 |
| D | .40 | .60 | .80 | 11 |
| E | .60 | .90 | 1.20 | 15 |
| F | .50 | .75 | 1.00 | 16 |

Income Tax

The concessionaire is obligated to pay an income tax on his net income and is further obligated to pay an additional tax, subject to a 50-50 limitation. This additional tax is payable following the period during which the concessionaire recovers his investment and is equal to the difference between 50 percent of net income and the amount of ordinary income tax payable plus other direct taxes and royalties.

Deductions

The concessionaire will be allowed to deduct from his gross income, for the computation of income tax, the following items: Surface taxes, royalties, direct taxes, import duties when applicable, depreciation expenses, mineral amortization (depletion allowance), and the cost of excavation, drilling, and other similar operations, as well as all expenses incurred by geological investigation and mineral exploration.

Losses sustained by the holder of the concession may be carried forward in accordance with the following table:

| Class | Years |
|---|---|
| A | 2 |
| B | 4 |
| C | 6 |
| D | 8 |
| E | 10 |
| F | 10 |

A mineral amortization or depletion deduction is authorized until the concessionaire has recovered his investment, although the deduction may not exceed 50 percent of the net income. The depletion deduction is a percentage of the gross extraction income less the surface taxes and royalties payable to the state. The annual deduction is as follows:

| Class | Percentage |
|---|---|
| A | 6 |
| B | 12 |
| C | 16 |
| D | 20 |
| E | 24 |
| F | 24 |

## Import and Export Duties

All equipment, accessories, and materials necessary for mineral operations, with the exception of gasoline, alcohol, and those which are produced in the country in sufficient quality and quantity, may be imported free from import duty and consular fees until the capital investment has been recovered.

Except for minerals designated as royalties in kind, and those required for internal consumption, all minerals extracted or processed may be exported free from duties or fees.

## Termination

In addition to terminating on the expiration date, concessions may terminate if there is inactivity in the operation for more than 1 year without justification. Concessions may be terminated at the option of the Government by cancellation. Cancellation may occur for the following reasons: (1) The holder does not meet his financial obligations, (2) the mining operations are not carried out in accordance with the concession contract, (3) the holder does not allow Government inspection, and (4) the holder fails to file the annual reports required of him in the Code.

# PUERTO RICO

## Controlling Statutes

The principal mining and petroleum legislation is the Puerto Rico Mining Law, Act No. 6 of October 6, 1954, as amended. This law is supplemented by the Regulations for Prospecting, Leasing and Producing Commercial Minerals in Puerto Rico of November 21, 1957, and by the Regulations for Prospecting, Leasing and Producing Oil and Gas in Puerto Rico of June 6, 1955, as amended July 11, 1956, and November 14, 1957.

## Administration

The mining law is administered by the Mining Commission, which consists of seven Commissioners, one each from the Planning Board, the Department of Agriculture and Commerce, the Department of Public Works, the Department of Justice, the Department of the Treasury, and two from the Department of Health.[1]

The Commission is empowered to promulgate regulations, grant permits and leases, resolve disputes, take land necessary for mining activities by eminent domain, and enforce the provisions of the mining law. Disputes concerning mining matters are settled by the Commission, and its decisions and findings are unappealable, with the exception of those disputes involving questions of law and those concerned with compensating the owners of expropriated land. In these cases an appeal may be taken to the Superior Court.

## Mining

All mineral substances designated "commercial minerals" are subject to the Mining Law. Ownership of these substances is vested in the Commonwealth of Puerto Rico. For classification purposes "commercial minerals" includes metallic and combustible substances, precious stones, and other substances declared to be commercial minerals by the Mining Commission because of their value or uses for industrial or other commercial purposes. Substances not classified as commercial minerals (e.g. siliceous and calcareous mineral substances) are not subject to the Mining Law and may be used or extracted without permission, subject only to the consent of the land owner and compliance with safety regulations.

Special provisions govern the exploitation of radioactive minerals. Areas under investigation by the Commission or which have been declared reserve areas are not subject to lease.

The regulations state that any person 21 years of age or more, and any corporation, either incorporated under the laws of the Commonwealth or qualified to do business as a foreign corporation in the Commonwealth, may obtain a mining permit or lease.

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[1] For information, write Mining Commission, Office of the Governor, P.O. Box 3088 G.P.O., San Juan, Puerto Rico 00929.

400-545 O - 70 - 7

## Exclusive Prospecting Permit

An exclusive prospecting permit gives the holder the right to explore for those minerals specified in the permit by means of surface geological and geophysical examinations and subsurface examinations.

The permit is granted for 1 year and is renewable for a maximum period of 9 years. The area of the exclusive prospecting permit is fixed by the Commission on the basis of the type of mineral sought, the estimated availability of the mineral, and the commercial value of the mineral.

The permit holder has the right to take samples by boring or drilling. At any time during the duration of the permit he may negotiate for a mining lease. Activities requiring the use of powered vehicles, earth movers, drills, or other equipment that affects the soil or crops may be carried out only with the permission of the Commission and the consent of the landowner.

In addition to a semiannual operational report, the holder is under an obligation to submit to the Commission within 3 months following the expiration of the permit a copy of all maps, measurements, assays, and other information obtained during prospecting.

## Nonexclusive Prospecting Permit

The nonexclusive prospecting permit is distinguished from the exclusive permit in that it is not limited to any specific mineral nor is the size of the prospecting area fixed. Radioactive minerals may not be prospected for under a nonexclusive prospecting permit. The permit does not grant a priority to a lease, and the prospector may not negotiate the terms and conditions of a lease prior to the discovery of the mineral. The initial term of the permit is for 1 year, renewable for 1-year terms.

## Mining Lease

Exploitation of commercial minerals may only be carried out under a mining lease granted by the Commission. Minerals not specified in the lease which are unexpectedly found to be mingled in the same mine with the specified minerals may be extracted, held, and disposed of by the lessee.

The Commission determines the number of mining grants to be included in the lease, according to the nature of the deposit and the operation requirements. A mining grant is a tract of land subject to lease not exceeding 10 hectares, the length of which may not exceed three times its width. The lease may be of any shape, provided boundary lines are perpendicular or parallel to every other boundary line.

The term of a lease is 30 years, renewable for additional periods of 30 years each. The lessee may surrender his lease in whole or in part so long as the remaining area of the lease is comprised of one or more full mining grants and conforms to the requirements relating to shape and area of new leases.

A mining lease authorizes the following activities: (1) Entrance and exit rights, (2) rights to occupation and modification of the surface area, and (3) other easements including the right to construct roads and other improvements necessary and suitable for the most effective use and utilization of the lessee's rights. Easements over private lands are acquired under the Puerto Rico Law of Eminent Domain upon payment of compensation to the landowner.

A lessee is under the obligation to begin exploitation within 6 months after the granting of the lease and to continue operations with reasonable diligence. As a condition to keeping a mining lease, the lessee must carry out development works on the leased area valued at progressively increasing amounts ranging from $100 per grant multiplied by the number of years elapsed to a maximum of $1,000 per grant. Development expenses may include surveys, excavations, analyses, and other investigatory or development expenses. In exceptional cases of low-grade minerals spread out over vast areas, the Commission may reduce the development-works requirement. In the event that the lessee does not incur the minimum development expenses during any one year, he may pay the difference in cash to the Commission.

Rights to build and operate refineries, treatment plants, and transportation facilities are included in a mining lease. The law requires that commercial minerals be refined as much as possible in Puerto Rico. Refinement in Puerto Rico is a condition of a lease and is a factor considered in determining the amount of royalty to be paid. Exporting of unrefined or partially refined or processed minerals will be permitted only if complete refining operations are commercially unsound in Puerto Rico.

Applications for a mining lease are made to the Commission and the holder of an exclusive prospecting permit has priority in the consideration of the applications. The Regulations require that the application be accompanied by a bond in such principal sum, not less than $1,000 and not more than $100,000, as the Commission may require.

## Fiscal Provisions

A fee of $100 per year must be paid for each exclusive prospecting permit. With regard to permits to prospect for radioactive minerals, or conferring the right to explore by means of an aerial survey, a deposit between $10,000 and $20,000 must be tendered to the Commission as security for possible damages caused to private and public property.

The holder of a mining lease must pay royalties in addition to the annual rental per mining grant. The sum of $50 per year per mining grant is fixed for up to 40 grants; additional grants are subject to a rental of $10 per year per grant.

Royalties, which are computed quarterly, are fixed in the mining lease and set by the Commission. The Commission's objective in fixing royalties is to obtain for the Commonwealth the highest financial return possible, while at the same time encouraging exploitation of low-grade ores. The Commission fixes royalties on the basis of estimated relationships existing

between the grade of ore and the available tonnage of reserves. Accordingly, the Mining Law provides that royalties are not to be less than 2 percent of the estimated mineral removed. The schedules of royalties found in the Regulations are based on the market value of the mineral, the grade and estimated tonnage of the deposit, the nature and location thereof, the estimated cost of removal, and other relevant information. The Regulations provide that (1) payment of the royalty be in cash, (2) a 20 percent share of the royalties goes to the surface owner, and (3) in matters concerning the interpretation of Regulation 5 (royalties) the Commission is the sole judge, with no appeal from its decision.

Under Law No. 19 of May 29, 1962, all machinery and equipment used in prospecting activities for minerals or petroleum under a permit of the Commission is exempt from property taxes.

## Petroleum

All oil, gas, and other hydrocarbons within the lands comprising the Commonwealth and the offshore areas under its jurisdiction are subject to the Mining Law, and ownership of these mineral substances is vested in the Commonwealth of Puerto Rico. The Regulations governing petroleum state that any person 21 years of age or more or any corporation, either incorporated under the laws of the Commonwealth or qualified to do business as a foreign corporation in the Commonwealth, may obtain a prospecting permit or oil lease.

### Oil Prospecting Permit

A permit is exclusive and is subject to the restrictions set forth in the Mining Law section of this summary. The holder of the permit has the right to explore for oil and gas by means of surface geological and geophysical examinations and subsurface examinations. No subsurface examination may exceed 200 feet in depth without specific permission from the Commission.

The permit is granted for 1 year and is renewable for a maximum period of 9 years. The application must (1) designate the location for which the permit is sought, (2) be accompanied by a fee of $10 for the initial term, and (3) be accompanied by a bond in the principal sum of $10,000, payable to the Commonwealth.

In addition to the semiannual operational report, the holder is under the obligation to submit to the Commission within 3 months following the expiration of the permit a copy of all maps and any other information concerning the presence of water, coal, gravel, sand, or potentially useful minerals.

### Oil Lease

A lease confers upon the lessee the right to extract, own, and dispose of oil and gas, but does not include the right to extract, own, or dispose of oil shale, bituminous sands, or helium.

The maximum area for which a lease may be granted is 1,250 drilling units (1 unit equals 16 hectares). A lease may contain more than one lease block, a lease block being a rectangular unit of land comprised of not less than four drilling units (64 hectares) and not more than 84 drilling units (1,344 hectares). If the lease is comprised of more than one lease block, each lease block must be separated by a distance of 2,000 meters, except that one corner of each of two lease blocks may fall at a common point. In the event that the location of the lease is to be comprised wholly or partially within the area covered by a permit held by the applicant, the applicant must surrender from the area covered by the permit one or more portions having a total area equal to or greater than the total area of the lease blocks to be covered by the lease.

The term of the lease is 30 years, renewable for additional periods of 30 years each. The lessee may surrender his lease in whole or in part, so long as the remaining area of the lease conforms to the above requirements relating to area and shape of new leases.

A lease authorizes the following: (1) Entrance and exit rights, (2) rights to occupation and modification of the surface, (3) rights to carry out any activity necessary for the drilling and deepening of wells, and (4) other easements including the right to construct roads and other improvements necessary and suitable for the most effective use and utilization of the lessee's rights.

A lessee is under the obligation to commence drilling within 6 months and to continue drilling operations with reasonable diligence. In the event that a lessee obtains production of oil and gas in commercial quantities, the Commission may require that other wells be driven. Every lease holder is under the obligation to (1) keep a daily detailed record of the well, (2) give notice of intent to abandon and to plug the well in accordance with the Regulations, (3) surrender every lease block covered by the lease upon which drilling has not commenced at the end of the first 10 years, and (4) comply with all the technical and safety features contained in the Regulations.

Upon a showing of necessity the Commission may issue special rules, regulations, and orders relating to the erection and operation of any plant or factory separating products from oil or gas or both. A certificate of compliance with the conservation laws, issued by the Commission, is a prerequisite to transportation of oil and gas.

Applications for a lease are made to the Commission and must (1) describe the area, (2) be accompanied by a fee of $50 and one half the rental for the first year under lease, and (3) be accompanied by a bond in the principal sum of $100,000, payable to the Commonwealth, with a surety approved by the Commission. Applications are considered in the order of presentation, but each applicant has a right to have his application considered.

## Fiscal Provisions

1. Rental fee.--The rental for the first year of a lease is $20 per drilling unit, and the annual rental thereafter is $40 per drilling unit payable in advance. The Regulations provide that expenditures incurred in exploration work in the lease area during the term of the lease, but before commercial exploitation, may be applied on account of the yearly rental of such lease.

2. Royalties.--Within 25 days after the end of each month the holder of a lease is under the obligation to file a return showing the gross value of all oil and gas produced by him during such month and any other information required by the Commission. The amount of royalty with respect to oil is fixed on a sliding schedule and ranges from 5 to 16-2/3 percent. The royalty on other liquid hydrocarbons and sulfur obtained by processing gas by absorption is 12-1/2 percent, and on gas 15 percent, but not less than three-quarters of one cent per thousand cubic feet. On any question dealing with the interpretation of Regulation 5 (royalties) the Commission is the sole judge, and there is no appeal from its decision.

# TRINIDAD AND TOBAGO

## Controlling Statutes

Trinidad and Tobago gained independence on August 31, 1962, and is a member of the British Commonwealth.

Petroleum operations are governed by the Petroleum Act, 1969 and the Petroleum Regulations, 1970. The Continental Shelf Act, 1969 regulates offshore petroleum activities. The Mines, Borings and Quarries Act of 1907 deals with working conditions and safety measures. No laws concerning concessions for minerals other than petroleum have been found.

The Ministry of Petroleum and Mines is primarily responsible for administration of these laws.[1]

## Petroleum

There are three types of land tenure in Trinidad. First, lands acquired before 1902 (after which all subsequent mineral rights were reserved to the Government) are wholly owned by private persons. Under the Oil Law Titles, development of these lands must be carried on by negotiation with the private owner.[2] Second, lands granted to private persons by the Crown after 1902 where mineral rights were reserved are known as "alienated" lands. Third, the Crown has exclusive mineral ownership in submarine areas and in Crown lands, where surface rights have not yet been granted.

Petroleum rights may be granted to persons or companies who maintain a registered representative in the country. A license is required before a person or company may carry out any mining activities in the country, and there are three types of exploration and production licenses which may be granted.

In addition there are other petroleum licenses which govern refining, liquefaction, pipelines, transportation marketing, and petrochemical leases and licenses issued prior to the present statutes will be converted to new licenses.

No license may be assigned or transferred without the prior consent of the Minister.

### Exploration License

The holder of this license is granted the nonexclusive right to carry on any activities specifically enumerated in the license. The license may be granted for a term not exceeding 3 years and may be renewed for a similar period.

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[1] For information, write Chief Technical Officer, Ministry of Petroleum and Mines, Cor. Frederick and Park Streets, Port of Spain, Trinidad, Trinidad, and Tobago.

[2] A digest of private lease appears as Exhibit No. 36 in Report of the Commission of Enquiry into the Oil Industry of Trinidad and Tobago, 1963-64. See Conveyancing and Law of Property Ordinance, Ch. 27, No. 12, Revised Laws of Trinidad.

### Exploration and Production (Private Petroleum Rights) License

The terms of a license to develop private lands must be negotiated with the owner, and the Governor-General shall, unless he determines otherwise, issue such a license. The duration of the license is 20 years, with further 20-year renewals possible.

### Exploration and Production (Public Petroleum Rights) License

The area granted in this license may range from a minimum of 500 acres to a maximum of 425,000 acres (composed of five contiguous blocks of 85,000 acres each). The term of the license is 6 years with a renewal for an additional 25 years. Prior to the end of the 23d year, the licensee may request a 5-year renewal, and further 5-year renewals may be granted.

During the first 3 years of the original license the holder cannot, under penalty of forfeiture, suspend exploration activities, unless caused by force majeure. By the end of the 6th year the license area shall be reduced by 50 percent, except that the Minister may allow the surrender of a lesser portion, and with an area of less than 5,000 acres, no reduction shall take place.

For the first 3 years of exploration there is a minimum annual expenditure requirement, as specified in the license, and the licensee must give the Minister a bond which equals the amount specified. When petroleum is discovered in commercial quantities, it must be produced without unreasonable delay, and production cannot be interrupted unless justified by technical or other reasons.

When production reaches a certain level, the licensee must build a refinery with a capacity of 50 percent of production, or arrange to have the oil refined by another company in the country. Production below this level may also be required to be refined locally.

All three licenses are subject to similar obligations. These include minimization of foreign personnel, maintenance of boundary markers, payment of reasonable compensation for any damages, and maintenance of detailed records.

The Minister is also empowered to grant permits for the exploration and production of minerals other than petroleum.

### Fiscal Provisions

There is a TT$2,000 (1 TT$ = US$0.50) fee for the issuance or renewal of exploration and production license upon issuance of an exploration license. The holder must deposit a TT$20,000 guarantee with the Treasury; upon issuance of an Exploration and Production License (Public), a guarantee of TT$100,000 must be deposited, in addition to the bond relating to the minimum expenditure obligation.

The holder of a license must make a certain minimum payment per acre which is determined by the Minister and specified in the license, and the use

of Crown land is subject to surface rents. A petroleum impost is levied at a rate determined by the Minister on all oil won and saved.

The holder of an Exploration and Production License (Public) must also pay a royalty on net petroleum won and saved at a rate to be stipulated in the license. In determining royalties the minimum payment mentioned above is counted as a deduction. All licensees, unless subject to an applicable exemption, must also pay a corporate tax (presently 45 percent of chargeable profits), import duties, and excise taxes.

### Offshore Operations

The Continental Shelf Act, 1969 subjects offshore operators to the taxations and legislation of the country. It empowers the Governor-General to issue regulations under the act and to amend existing petroleum regulations.

# ARGENTINA

## Controlling Statutes

The Mining Code of 1886, Law 1919 of November 25, 1886, governs the development of minerals other than oil and gas.[1] Law 17,319 of June 23, 1967, governs the development of petroleum resources.

## Mining[2]

### Administration

Decree No. 1026/52 created in each province a Mining Authority with responsibility for the enforcement and administration of the Mining Code. Each Mining Authority is subordinate to the National Mining Administration (Direccion General de Mineria). The National Mining Administration is primarily a technical organization; it also acts as the authority for granting mining rights in the National Territory of Tierra del Fuego.

Article 2518 of the Civil Code vests complete ownership of the mineral estate in the surface owner, subject to the limitations of article 2342 which excludes gold, silver, copper, precious stones, and fossil substances from private ownership. A further limitation is found in article 7 of the Mining Code which provides that mines are the private property of the Nation or of the Provinces, according to the territory in which they are found. These two provisions must be interpreted in the sense that in either case, national or provincial, this is not ownership but rather jurisdiction or eminent domain.

With respect to private ownership of mines, the Mining Code (articles 8 and 9) provides that private persons may be granted a concession to search for mines, to make use of them, and to dispose of them as owners in accordance with the Code. The state, according to these provisions, cannot exploit or dispose of mines except in those cases explicitly mentioned in the Mining Law.

Mines, under Argentine law, are property that is distinct from that of the land in which they are found; but ownership, except as specifically provided in the Mining Code, is governed by the same principles as those covering ordinary ownership of property. Mines may be alienated, leased, or mortgaged like any other real property.

The Mining Code divides mines into three categories, depending upon the nature and location of the deposit.

Category 1 minerals belong exclusively to the state and may be exploited only through a concession. This class of mines includes all the precious

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[1] An Executive Power Decree, signed April 27, 1956, abrogated the 1949 Constitution and restored the 1853 Constitution. On September 25, 1957, a constitutional assembly ratified this decree and restored the Mining Code of 1886.

[2] For information, write Direccion Nacional de Geologia y Minera, Avda. Julio A. Roca No. 651, 10 Piso, Buenos Aires, Argentina.

metals which are enumerated specifically in the Code, fuels such as anthracite, lignite, and mineral oils, arsenic, and precious stones. Several recent laws have added tungsten, mica, aluminum, beryllium, vanadium, uranium, and thorium.

Category 2 minerals are divided into two subdivisions and comprise those which may be exploited by anyone without concessions and those which are granted preferentially to the landowner. The first subdivision consists of those metallic sands and precious stones which are found in the beds of rivers, running water, and deposits along the sides of streams, as well as the workings and wastes of abandoned mines. The second subdivision of this class of mines includes borates, saltpeter, salt, peat, metals not comprised in the first class, and various classes of earths, such as borates and those containing aluminum, kaolin, phosphates of lime, etc.

Category 3 minerals include mineral substances of a rocklike or earthy nature which are used for construction or ornamentation. This group of minerals belongs to the owner of the surface. If they are found on land owned by the State or municipalities, they may be worked by contract, or, if no contract exists, may be exploited by anyone.

Foreign individuals and corporations, after registering properly, may engage in mining activities. Argentina does not require that foreign corporations create a local subsidiary; however, they must be able to prove that they are validly formed in their domestic jurisdiction and that such jurisdiction grants reciprocity.

## Exploration Permit

In order to undertake exploration, on either public or private lands, a Government permit granting exclusive exploration rights must be obtained. The owner of private lands needs no permit to explore his own lands, but cannot interfere with persons entering the land under a Government permit.

The unit of measurement for an exploration permit is 500 hectares, if the land is either cultivated, worked, or fenced; otherwise four units, or 2,000 hectares, may be obtained. If the permit covers one unit of measurement the prospecting may be undertaken for 140 days, and for four units this may extend to a maximum of 300 days. These periods begin to run 30 days after the grant of the permit, within which time the works necessary for exploration must be installed, under penalty of loss of the permit.

If within the prospecting period the explorer declares that he wishes to establish formal operations to prove the existence of a deposit, or its importance or constancy, he may apply for and obtain three claims (pertenencias) of 300 meters by 200 meters, within which he may work to an indefinite depth. The period for such reconnaissance may not exceed 15 months. When the deposit is defined, the holder may obtain a formal mining concession.

The holder of a prospecting permit may not undertake formal exploitation nor extract minerals, but he may make use of and dispose of those found on the surface or those that must be taken out in the work of prospecting.

## Exploitation Concessions

The Code authorizes three types of exploitation concessions, which are (1) for the discovery of new minerals or new deposits, (2) for new mines, sometimes called estacas, and (3) for abandoned or forfeited mines.

1. Concession for discovery.--This is the primary concession right, and gives the discoverer of a new mineral (discovery is located where no other deposit is registered within a radius of 5 kilometers) the right to select three contiguous claims or claims separated by a space equal to one or more claims, in one deposit, and two additional claims, contiguous or separate in other deposits that are or may be discovered. The discoverer of a new deposit of a known mineral has the right to two contiguous or separate claims. If the discoverers are two or more persons organized as a company, they are entitled to two additional claims; if there are four or more persons they are entitled to four additional claims. The size of the claim is a rectangle of indefinite depth which measures 300 meters by 200 meters, except that the latter measurement may be 300 meters, depending upon the dip of the deposit.

2. Concession of new mines (estacas).--Any person may apply for the free portion of a deposit that has been discovered, registered, and granted in concession, for an area equal to one claim, to be reconnoitered or explored for a period of 100 days. Application may also be made for a new mine as a continuation of a registered mine but on the opposite side of the slope of its shaft and outside its width, having a free space of one claim between the proposed and registered claim.

3. Concession of abandoned mines.--The concession holders of mines lose their rights in two ways: by an express statement of abandonment filed with competent authority, or by forfeiture due to failure to pay the surface tax for 1 year or noncompliance with the requirement of investing a minimum amount of capital in the mine. In either case the mine is declared vacant and may be reacquired by another person. A person working a vacated mine is entitled to the same privileges as a discoverer of a new mine.

Three categories of minerals were described above. For the purposes of discussing exploitation concessions, the most important category of minerals is the first category, which includes those minerals that belong exclusively to the State.

Category 2 minerals are divided into two groups: minerals open to common appropriation, and minerals granted preferentially to the landowner. The minerals open to common appropriation (that is, metal bearing sands and precious stones found in riverbeds, and waste materials from former concessions) may be exploited with or without a concession. Should they be exploited under a concession the general concession rules apply. The second group, minerals granted preferentially to the landowner, may be obtained by nonlandowners if the landowner when notified of the application fails to indicate within 20 days his intention to exploit them and does not commence exploitation within 100 days. If a concession is granted under such conditions the same rules apply as for any other concession.

The third category contains minerals which belong exclusively to the landowner and thus may only be obtained through an agreement with him.

Mining concessions are granted for an indefinite period but the validity of the concession is subject to three conditions: (1) Payment of an annual surface tax (canon) on each claim, (2) investment of a minimum amount of capital, and (3) reasonably diligent exploitation.

Within a period of 4 years a concessionaire must invest a fixed minimum amount of capital in plants, machinery, and works directly benefiting the exploitation. The minimum amount is determined by the authorities on the following basis: Category 1--10,000 to 40,000 pesos; category 2--3,000 to 10,000 pesos.[3] If the concessionaire fails to comply with this obligation, the concession is forfeited without the right to claim indemnity for the work that has been carried out.

The concessionaire is under an obligation to commence his operations within 100 days after receiving a concession, and undertake development work sufficient to show the location, direction, and thickness of the deposit. The concessionaire must continue to work the mine with reasonable diligence, taking into account the optimum rate of production, the characteristics of the region, available means of transportation, demand for the product, and the availability of labor.

When a concession has been granted, the surface land becomes subject to the following easements, subject to payment of compensation: (1) Occupation of a suitable area for housing, offices, smelters, machinery, yards, and dump heaps, (2) occupation of land for establishing means of communication and transportation, and (3) use of natural waters for the needs of exploitation.

## Fiscal Provisions

For substances listed in category 1 and for minerals obtained from rivers and placers, the annual surface tax is fixed at 100 pesos per claim; for category 2, with the exception of placers, the annual surface tax is 50 pesos for each claim.

Law No. 10,273 exempts the discoverer of a new mineral from the surface tax for the first 3 years and the discoverer of a new deposit for the first 2 years. In addition, for the first 5 years a concession is exempt from all other forms of taxation except the surface tax.

Income from mining operations in Argentina is subject to Federal taxation under Law 11,682. Foreign corporations and domestic corporations partially or wholly owned by foreign companies pay a flat 38.36 percent rate on all profits from local operations.[4] Under Law 17,432 of September 11, 1967, a 100-percent

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[3] On January 1, 1970, a "new peso" ($a), equivalent to 100 old pesos (m$n), became the official currency unit. Old pesos were valued at US$0.0029. 1 new peso = US$0.286.

[4] During periods in the past, all taxes have been increased by 15 percent under an emergency surtax law.

credit against income tax liability was provided for investments in capital goods to be used in exploration, extraction, or processing of minerals within the country.

Failure to pay taxes, failure to meet the specified minimum investment, or abandonment by the owner or concession holder terminates all ownership in the mining property. Any expired mining concession reverts to the ownership of the State, which may dispose of it at public auction, but the owner may retain the mine by paying double the amount of tax due plus costs incurred (article 7 of Law 10,273, amending article 274 of the Mining Code).

### Fissionable Materials

Decree Law 22,477 of 1956 (ratified by Law 14,467 of 1958) established special rules governing exploration and exploitation of nuclear elements and minerals--uranium, thorium, and plutonium. Prospecting is open to anyone, but exploration involving digging or drilling requires an exploration permit in accordance with the provisions of the Mining Code for category 1 minerals. Exploitation contracts are made with the National Commission on Atomic Energy for a term no longer than 20 years, renewable for 10-year periods. All production is the property of the Nation, and the National Commission is responsible for the disposition of the ores and concentrates.

### Strategic Minerals

Under Decree-Law 9009 of 1963, for reasons of military security, exploration permits and concessions for certain strategic minerals in the vicinity of the Chilean frontier, in Mendoza and Neuquen Provinces, may be granted only by the War Department through the General Board of Military Manufacturers.

### Petroleum

The Secretary of State for Energy and Mining is responsible for the administration of the 1967 petroleum law, but the National Executive Power retains broad powers to decide the following matters: (1) To determine the areas for exploration and development, (2) to award and extend permits and concessions, and approve their transfers, (3) to stipulate solution of disputes by arbitration, (4) to cancel tenders, (5) to assign and modify the areas reserved to the state-owned enterprises, (6) to determine the areas barred from surface reconnaissance, (7) to approve mixed companies and other third-party contracts entered into by state-owned enterprises, (8) to establish compensation payable to the surface owners, and (9) to terminate permits and concessions.

The National Executive Power may grant to qualified private enterprises, which establish domicile in Argentina, exploration permits and exploitation concessions to develop oil and gas resources located in areas outside those reserved exclusively for exploitation by the state enterprises: Yacimientos Petroliferos Fiscales (YPF) and Gas del Estado. The total Continental Shelf and the remaining onshore areas remain open to private enterprise. The territory open for new rights is divided into two types--"proven" and "possible." Exploration permits are only granted in "possible" zones (article 10).

Holders of exploration permits and exploitation concessions are to have possession of the hydrocarbons they extract, and may transport, process, and sell them and their derivatives pursuant to regulations set forth by the National Executive Power. During the period in which indigenous production of petroleum is insufficient to cover domestic needs, the entire output of locally produced petroleum must be made available for internal consumption.

For as long as the total output of petroleum remains less than domestic consumption, the National Executive Power is authorized to fix prices for internal consumption. The prices are to be the equivalent of those set for YPF but not less than the prevailing price of similarly imported crudes. After normal internal needs are met, the Executive may permit the export of crude but will continue to establish regulations governing the domestic market.

Natural gas output in excess of field use must be preferentially offered to the State agency, Gas del Estado. With the approval of the Secretary of State for Energy and Mining, the concessionaire may dispose of gas not delivered to Gas del Estado.

### Surface Reconnaissance

Any person may undertake surface prospecting in search of hydrocarbons within the territory of Argentina or its Continental Shelf, with the exception of those zones covered by exploration permits or exploitation concessions or within those zones reserved exclusively for state-owned enterprises. Upon approval of the competent authority a surface prospecting permit will be issued specifying the type of reconnaissance to be performed, the length of time for which the permit is valid, and the dimensions of the zones within which the reconnaissance is to be carried out.

### Exploration Permit

Exploration permits are granted for a basic 9-year period (initial 4 years, plus 3, plus 2), with an optional extension period of up to 5 years. Each of the basic terms for onshore exploration may be extended by the addition of 1 year in the case of exploration performed on the Continental Shelf.

The maximum aggregate surface area of a permit cannot exceed 100 units onshore or 150 units on the Continental Shelf--the basic exploration unit being 100 square kilometers. No person may hold, either directly or indirectly, more than five exploration permits at one time. As the terms of the basic period expire, the Code requires periodic reductions in the area of the permit.

The holder of the permit is authorized to undertake the following activities: (1) Geological and geophysical studies, (2) topographic and geodetic surveys, (3) the drilling of exploratory wells, and (4) other activities necessary in the search for hydrocarbons.

## Exploitation Concession

The holder of an exploration permit, upon the discovery of hydrocarbons in commercial quantities, is entitled to an exploitation concession within the permit area. All discoveries must be reported to the National Executive Power within 30 days, and upon application and exploitation concession will be granted in 60 days. In "proven" areas, exploitation concessions may be granted by the National Executive Power by competitive bidding.

The maximum area of the concession must coincide as closely as possible with the underlying oilfield, and in the case of a concession in a "proven" zone the maximum area may not exceed 250 square kilometers.

The term of an exploitation concession is 25 years. A 10-year extension is possible. Upon the expiration of the concession, all normal operating and maintenance equipment reverts to the State.

The holder of an exploitation concession has the nonexclusive right to obtain a transportation concession, valid for 35 years with a possible 10-year extension.

## Fiscal Provisions

Holders of exploration permits and exploitation concessions must pay (1) all provincial and municipal taxes, (2) all customs duties, import and exchange surcharges, and rents (surface taxes), and (3) a special income tax on net profits.

1. Surface tax.--The holder of an exploration permit is required to pay in advance an annual surface tax for each square kilometer encompassed by the permit. The amount of this tax varies as follows: 500 pesos for the first term, 1,000 pesos for the second term, 1,500 pesos for the third term. For the first year of the extension period, the rate is 100,000 pesos, increasing 50 percent each year. An allowance for investment may reduce this fee to a minimum of 10,000 pesos per square kilometer.

The holder of an exploitation concession must pay in advance an annual surface tax of 20,000 pesos per square kilometer.

2. Royalty.--Hydrocarbons produced during exploration are subject to a 15-percent royalty payment.

Each exploitation concessionaire is required to pay to the State a royalty of 12 percent of the value at the well head of the liquid and gaseous hydrocarbons produced or extracted. This may be reduced to 5 percent by the National Executive Power, depending upon rate of production, condition, and location of the wells.

3. Special income tax.--Concessionaires are required to pay a special income tax of 55 percent upon their net taxable profits; however, this percentage may be reduced as low as 47 percent at the discretion of the National Executive Power.

The concessionaire's payment of taxes, rents, and royalties will be deducted from the income tax obligations to the State; or if in excess of the liability, credited as prepayment of future obligations.

# BOLIVIA

## Controlling Statutes

The law governing mining is the Code of Mines, D.S. No. 07148 of May 7, 1965. This Code supersedes the Saavedra Code of 1925. The development of petroleum resources is governed by the Petroleum Code, D.S. No. 4210 of October 26, 1955, and regulations, D.S. No. 4298 of January 24, 1956.[1]

## Mining

Under the Code all mineral substances are within the dominion of the state, and right to acquire minerals may be obtained by concession from the state.

Foreign individuals and companies domiciled in Bolivia may engage in mining activities, except within 50 kilometers of the border. Foreign mining corporations must have their legal status acknowledged, and for this purpose must forward to the Ministry of Mines certain information specified in the Code. Foreign companies may obtain concessions before they have been granted legal status, subject to their legal status being recognized.

The Code classifies minerals as follows. Concessions for exploitation of common salt and alluvial and eluvial deposits of gypsum, lime, quarry stone, and ochres are preferentially granted to the surface owner. Gold, precious stones, and rare metal concessions are subject to regulations and special contracts entered into with the State.[2] Otherwise, rights to minerals are obtained through concessions issued under the Code.

Mines are classified as large, medium, and small. Large mines include the state-owned mines which are operated by the Corporation Minera de Bolivia. The private mining industry is composed of medium and small mining enterprises. Medium mines must satisfy monthly minimum production rates specified in Decree 5674 of December 30, 1960. Medium miners are free to sell their production to the buyer of their choice. All other mines fall into the small category and are subject to restrictions on sale of production.

## Administration

There is a Superintendent of Mines in each of the nine Departments (States) of Bolivia who is authorized to grant land exploration and exploitation concessions, to declare forfeitures, and to settle disputes. Mining registers and other records are maintained by the Superintendents.

The National Court of Mines, located in La Paz, hears appeals from the decisions of the Superintendents of Mines.

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[1] Decree of October 17, 1969, nationalizing Gulf Oil Company indicates that the Bolivian Government has annulled the Petroleum Code.

[2] Decree Law 7678 of June 22, 1966, regulating gold mining in "reserve" zones.

The Department of Mines has its headquarters in La Paz and is responsible for a variety of administrative matters relating to the mining industry.[3] Its Technical Service advises the Superintendents of Mines concerning their responsibilities.

The Executive Power may declare areas to be under fiscal reserve in order to authorize development under special contracts and for other national purposes. Exploitation with fiscal reserves is subject to special laws. The National Council of Mines is an advisory organization to assist the Executive Power in implementing national mining policy.

Applications for concessions, text of concessions, and other matters must be published in the Boletin de Minas (Mines Bulletin).

## Exploration

Exploration activities are divided into three categories: aerial surveying, prospecting, and land exploration.

The state has the exclusive power to authorize aerial surveying. Applications for licenses are submitted to the Ministry of Mines.

Prospecting consists of minor preliminary work in search of mineral substances. Any person can prospect on free land, but he is prohibited from digging more than 10 meters in length or depth.

To obtain a land exploration or exploitation concession, a prospector must file an application according to the applicable sections of the Code. Land exploration concessions give an exclusive right to explore underground as well as on the surface for mineral substances, and an exclusive option to obtain exploitation concessions within the exploration area. Applications for exploration concessions are submitted to the Superintendent of Mines in the local Department. Grantees must start operations within 6 months of the exploration adjudication decree, and may not interrupt operations for more than 6 months. They must submit semiannual reports to the Minister of Mines. The unit of measurement for exploration concessions is the "pertenencia" which has a square area of 100 meters per side (1 hectare). A land exploration concession may cover from 2 to 20,000 pertenencias. Although the Code does not specify how many exploration concessions may be held, a concessionaire may renounce one area and obtain others at the same time provided a total area of 20,000 hectares is not exceeded. Land exploration concessions are granted for 2 years. The grantee may request an extension for 1 year if he reduces the area of his concession to half its original size. Once the concession has expired, the grantee will not be granted another exploration concession for the same area.

## Exploitation

Mining concessions are divided into four categories: exploitation concessions; concessions for abandoned dumps, slags, and tailings; mineral

[3]For information, write Direccion General de Minas, Ministerio de Minas y Petroleo, La Paz, Bolivia.

treatment plants; and mineral smelting plants. Treatment plant and smelting plant concessions are granted by the Ministry of Mines.

An applicant for an exploitation concession must submit to the Superintendents of Mines an application in the form prescribed by law and a plan of the concession. Detailed provisions concerning technical reports, marking proceedings, and opposition proceedings are set forth in the Code.

An exploitation concession is granted for an unlimited time, as long as patents are paid and compulsory work is done. Grantees must commence operations within 1 year of the adjudication decree and may not interrupt workings for more than 2 years, except when force majeure or unfavorable market conditions interrupt and extensions are granted. The unit of area for exploitation concessions is the "pertenencia" (square area of 100 meters per side). The total area held by an exploitation grantee may not exceed 20,000 pertenencias.

Whenever there is free space between two or more concessions which will not form a claim even if the total area is more than 10,000 square meters, this free land is termed a demasia and will be granted to the first adjacent concession holder or to any other person who applies for it (if no other holder applies within 30 days).

An exploitation concession gives the grantee the exclusive right to exploit, treat, smelt, and indefinitely profit by the mineral substances he may obtain within the boundaries of his concession. No special permission must be obtained in order to install treatment plants or smelters. The grantee can construct all necessary workings, within the limits of the concession, and have free use of adjacent, unused public dominion land.

Concessions for abandoned dumps, slags, and tailings are granted by the Superintendent of Mines to the first applicant. These concessions are subject to payment of patents, continuous working, and fulfillment of other obligations under the Code.

Mining concessions and rights are transferable and may be leased. Exploitation concessions can be mortgaged in the same manner as real estate. The rights of public utility are granted to private mining activities. Grantees may make arrangements with landowners for required easements. If the parties cannot agree, the grantee may expropriate whatever land he requires for his mining operations. Grantees are obliged to indemnify landowners for any damages caused by their operations.

Grantees have complete technical freedom, subject only to the principles of industrial safety. Suspension of mining works may be ordered in order to protect the health and safety of workmen. Grantees must keep production records, and must provide free access to all installations to authorized officials of the Ministry of Mines. The Code contains special guarantees against the occupation of mines by labor unions and cooperatives.

Grantees, in general, can renounce or reduce the area of their concessions at any time. The Ministry may terminate concessions for failure to

comply with provisions of the Code. Specified violations cause forfeiture without further proceedings; otherwise, a decree is required to effect a forfeiture.

## State-Owned Enterprises

The state mining industry includes the Corporacion Minera de Bolivia, the Banco Minero de Bolivia, the National Smelting Corporation, the Comision Boliviana de Energia Nuclear, and other state mining entities.

The Corporacion Minera de Bolivia is authorized to manage the mines which were nationalized on October 31, 1952, the dumps, slags, and washings of the concessions and mining camps which constitute the nationalized mining groups, and concessions it may acquire under the Code.[4] The Banco Minero de Bolivia, a self-governing state entity, promotes private mining enterprises and the treatment and smelting industries. The National Smelting Corporation, also a self-governing state entity, gives advisory assistance to the Government regarding technical and administrative matters related to smelting and installation of smelting plants. The Code declares that the state will endeavor to achieve the integration of the national mining industry with the establishment of smelting plants.

Uranium, thorium, and other radioactive materials have been nationalized by the state under D.S. No. 08339 of April 17, 1969, and an autonomous Government entity, Comision Boliviana de Energia Nuclear, has been granted the right to explore for nuclear and radioactive materials.

## Fiscal Provisions

Miners have the right to sell their minerals abroad or within the country to whomever they may choose, with the exception of small miners who have debts with Banco Minero and are obliged to cover them before selling their mineral production to other buyers.

Gold producers sell their gold to the Banco Minero or Banco Central at the international price.

At the time of exporting their products the amount is fixed by the state for each mineral on the basis of their fine content and the international price. Mining operators pay a royalty in substitution for all other taxes, with the exception of the "Global Complementario," a surtax on dividends received by shareholders. Supreme Decree 7360 of October 8, 1965, established a new scale of royalties payable by exporters of tin ores. Supreme Decree 6462 of May 10, 1963, requires royalty payments on exports of smelted tin and tin alloys. Supreme Decree 7447 of December 22, 1965, fixes the royalty scales for wolfram, antimony, copper, lead, zinc, silver, and bismuth. Certain salts, clays, stones, and beryllium are exempt from export royalties. Minerals not mentioned in this decree pay a royalty of 2.5 percent of gross value. Under this decree smelted ores and alloys produced in Bolivia are exempt from royalty payments.

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[4] D.S. 3196 of Oct. 2, 1952, D.S. 3869 of Nov. 8, 1954, and D.S. 4113 of July 7, 1955.

Patents (surface taxes) are paid independently from royalties. Exploitation grantees pay an annual patent per pertenencia which ranges from 1.20 pesos (1 peso = US$0.084) for the first 5,000 pertenencias to 6.00 pesos for over 20,000. Upon applying for a land exploration concession, a patent equal to one-half of the exploitation patent is payable. Where an extension is granted, the same amount is payable. Additional land assessment taxes are imposed by various Departments.

Under law of December 18, 1933, a transfer tax of 2 percent is levied on conveyance of mining property. Supreme Decree 7074 of February 26, 1965, levies a tax of 15 percent on mining concession rentals. Under Supreme Decree 7075 of February 26, 1965, sales of minerals through intermediaries are subject to 0.6 percent tax on the proceeds. Material and equipment needed for mining exploitation are exempt from import taxes (Decree Law 7366 of October 20, 1965, and Supreme Decree 7900 of January 18, 1967). Supreme Decree 3299 of January 16, 1953, imposed a single tax of 25 percent on mining profits.

## Petroleum[5]

The Petroleum Code governs the development of petroleum, asphalt, natural gas, and other hydrocarbons. The purpose of the Code is to develop the petroleum industry by encouraging foreign capital to invest in it, while retaining certain advantages to the state through the use of state-owned petroleum enterprises. Under the Code concessions may be acquired by any person having the necessary technical and financial capacity, including foreign companies and persons. In April 1968 a decree was issued which prohibits granting oil concessions under the Code. Rights of outstanding concessions were not affected. The Bolivian Government, however, on October 17, 1969, expropriated the properties of the Bolivian Gulf Oil Company. The extent of renumeration to be paid to the company as a result of the nationalization has not yet been determined.

The Yacimientos Petroliferos Fiscales Bolivianos (YPFB), a state-owned autonomous entity, has the exclusive right to explore and exploit petroleum within its zone. The Code divides the country into zones I, II, and III, and the YPFB zone, an area where YPFB has its principal oil development. YPFB can apply for petroleum rights in the other zones on the same terms as private companies; it is permitted no special privilege or advantage. The other zones are open to private exploration and development, except certain areas in zone I that are under contract to Brazil. In the YPFB zone, the company can join with private interests to work an area, but the YPFB must retain 51 percent of the shares. Concessions within 50 kilometers of the frontiers are prohibited unless under contract with YPFB within its zone of operation.

### Administration

The Executive has delegated some authority to the Direccion General de Petroleo (Petroleum Administration) to approve certain concessions

[5] While the Petroleum Code has been annulled, its provisions are given in order to exemplify prior government procedure.

applications, settle certain disputes, and make technical decisions and determinations.[6] Appeals from concession grants and disputes over rights previously granted may be taken to the Supreme Court of Justice.

## Reconnaissance Permits

Reconnaissance operations may be carried out under nonexclusive permits covering specified areas. There appears to be no limit on the size of the area covered by a permit. A permit has a term of 1 year and is renewable, but it is also subject to cancellation on 60 days' notice. All types of exploration work, except drilling, may be carried on under a permit.

## Exploration-Exploitation Concession

This concession confers the exclusive right to explore an area for the time fixed in the Code, and the right to produce petroleum. Concessions are awarded by competitive bidding; priority of application grants no preferential rights. The exploration term is 4 years in zones I and II, and 6 years in zone III; renewals for 2-year terms are allowed only in zones II and III. The minimum area of an exploration concession is 5,000 hectares. Exploration concessions may not exceed the following limits: Zone I, 150,000 hectares; zone II, 400,000 hectares; and zone III, 750,000 hectares. A single company may hold a total of not more than 0.5 million hectares in zone I, 1.5 million hectares in zone II, and 3 million hectares in zone III.

An exploration concessionaire must start work within 6 months of the granting of the concession, and must make a minimum annual investment of US$0.80 per hectare in zone I, US$0.50 per hectare in zone II, and US$0.20 per hectare in zone III. During any period of extension the minimum annual investment increases by 30 percent. Annual exploration surface taxes per hectare payable during the first term are US$0.05 in zone I, US$0.03 in zone II, and US$0.02 in zone III.

## Exploitation Concessions

The holder of an exploration concession may acquire an exploitation concession with a term of 40 years. On conversion from exploration to exploitation, areas retained may not exceed one-half the area originally granted. Maximum areas for exploitation concessions are 75,000 hectares in zone I, 200,000 in zone II, and 375,000 in zone III. No single company may hold a total of more than 0.5 million hectares in zone I, 1.5 million hectares in zone II, and 3 million hectares in zone III.

During the first 7 years the holder of an exploitation concession must drill one or more wells to a total depth of at least 5,000 meters for each 100,000 hectares held; during the next 8 years two or more wells must be drilled to a total depth of 10,000 meters for each 20,000 hectares. A concessionaire has the right to renounce all or any part of the concession at any time.

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[6] For information, write Direccion General de Petroleo, Ministerio de Minas y Petroleo, La Paz, Bolivia.

An initial exploitation surface tax per hectare is US$0.40 in zone I, US$0.30 in zone II, and US$0.20 in zone III. An annual exploitation surface tax per hectare is US$0.15 during the first 5 years, and $1 in the last 10 years in zone I, US$0.10 and US$0.50 in zone II, and US$0.08 and US$0.30 in zone III. The royalty of 11 percent, payable in kind or in cash, may be reduced to 7-1/2 percent in zones II and III for not longer than 15 years. The surface tax and the royalty are inherent obligations of the concessionaire and must be paid even if it results in a loss. Although the royalty is set-off against the surface tax, a concessionaire must always pay the minimum surface tax.

The concessionaire is subject to a fixed income tax of 30 percent of net earnings. Deductions allowed include costs of exploration, intangible drilling and development costs, administration, and a 27-1/2-percent depletion allowance. Carryover of previous operating losses as a deduction before assessment of taxes is allowed for as long as 7 years. Remaining net income which exceeds 10 percent return on unamortized capital, after payment of the 30 percent tax and deductions, is subject to an excess profits tax of 50 percent. The cumulative taxload may not exceed 50 percent of net income. If taxes and royalties exceed 50 percent of the net profits of the concessionaire for any one year, they are credited against future taxes and royalties.

The petroleum industry is given the status of a "public utility" and thus receives certain privileges: immunity from attachment for its property and immunity from having its activities interrupted by unions or the Government. The concessionaire is not subject to general taxes. He is also exempt from import duties on certain equipment; "special equipment" is exempt for 2 years plus a 2-year extended period, at which time the equipment must be exported.

The Executive Power has the authority to require concessionaires to supply the country's domestic needs. The concessionaire is not taxed on exports of petroleum. Proceeds from the sale of petroleum may be retained within the country or abroad. He may import and export capital as well as profits freely.

## Refining and Transportation

The exploration and exploitation concessions may carry with them the right to refine and transport, or may require that separate concessions be issued for those operations. Refining and transportation concessions are subject to general taxation, as well as to the special petroleum taxes.

## The YPFB Zone

Under article 20 of the Petroleum Code, the rights of YPFB to a considerable area in the southeastern corner of the Chaco (bordering Argentina and Paraguay) were confirmed. For petroleum exploration and/or exploitation within its zone, YPFB is empowered by article 161 of the Code to enter into "contracts of rental or operation" with private persons. These contracts must receive the prior formal approval by the Executive Power.

# BRAZIL

## Controlling Statutes

Development of mineral resources other than petroleum is governed by the Brazilian Mining Code (Decree-Law No. 227 of February 28, 1967), as amended by Decree-Laws 318 of March 14, 1967, and 330 of September 13, 1967.[1] Development of petroleum resources is a Government monopoly under Law 2004 of October 3, 1953, as amended by Law 3257 of September 2, 1957.

## Mining

All minerals except fissionable minerals, liquid fuels, and natural gas are subject to the Mining Code.

### Administration

The National Department of Mineral Production (DNPM) is charged with the enforcement of the Mining Code.[2] Permission to prospect and mine is obtained through issuance of an authorization to prospect by the Minister of Mines and Energy, and the grant of a mining concession by decree of the President of the Republic. The DNPM maintains registers of exploration permits, mining decrees, known deposits and mines, and mining companies.

A special registry is kept on trade in precious stones, precious metals, and other minerals specified by the regulations. This trade is under the authority of the Ministries of Mines, Finance, and Industry and Commerce through the Department of Mineral Production, the Directorate of Internal Revenue, and the Department of Commerce, respectively.

### General

The surface owner has preferential rights to mine deposits of mineral substances used for construction purposes. In general, all other minerals may be developed only under an authorization and a concession.

The Code divides mines into two categories. A mine is "manifested" when it is being worked (even though operation was temporarily suspended on July 16, 1934) and it had been manifested in accordance with article 10 of Decree No. 24,642 of July 10, 1934, and of Law No. 94 of September 10, 1935. A mine is said to be "conceded" when the right to work it has been ratified by a decree issued by the Federal Government.

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[1] Decree No. 65,202 of September 22, 1969, regulates exploration of mineral resources on land occupied by Indians.

[2] For information, write to Divisao de Fomento da Producao Mineral, Departmento Nacional da Producao Mineral, Anda. Pastem 404, Rio de Janeiro, Brazil.

Exploration and exploitation rights may be granted only to Brazilian natural or juridical persons, or to "mining concerns."[3] The Code defines "mining concern" as a Brazilian firm or association or corporation domiciled in Brazil, having for its objectives the development of mineral deposits in the national territory. Members of the "mining concern" may be Brazilian or foreign individuals, or juridical persons. Authorization to operate as a "mining concern" must be granted by the Minister of Mines and Energy.

### Exploration

Authorization to prospect is granted in the form of a permit from the Minister of Mines and Energy. The permit specifies the area to which it applies by locality, boundaries, and surface area in hectares.

No person may hold more than five authorizations to prospect deposits of the same class. Permits are granted for an initial 2-year term, and may be renewed for 1 year.

Landowners are entitled to rent for the use of their land and indemnification for damages. In the absence of an agreement between the landowner and the permittee, the Department of Mines may order a deposit to be made equivalent to 2 years' rent, and a security bond to be posted for indemnification, before permitting exploration.

Exploration must begin within 60 days of the publication of authorization to prospect in the Official Gazette, and may not be suspended for more than 3 consecutive months or for 120 nonconsecutive days.

When the final report of exploration is filed and approved, the permit holder has 1 year within which to request an exploitation concession. After that period, the Government may grant exploitation rights to other petitioners.

### Exploitation

An exploitation concession entitles the concessionaire to extract and to process specified minerals. A concession may be granted only to a registered "mining concern," over a previously explored area. There are no restrictions placed on the number of concessions which may be held by one concern. The Code provisions relating to the size of the concession provide that the mining area must be of adequate size to ensure successful economic and technical operations within the limits of the exploitation area.

In zones of National Reserves, or in the case of a mineral subject to a monopoly, the Government may authorize prospecting for other minerals, provided the work is compatible with, and independent from, that relating to the "Reserve" mineral.

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[3] On July 25, 1965, the Supreme Court of Brazil upheld the right of Brazilian corporations with foreign shareholders to acquire exploration and exploitation concessions. This decision set aside article 6 of Decree-Law 1,985 of January 29, 1940 (excluding foreigners from holding any interest in a Brazilian mining company) as being in direct conflict with the legislative history of articles 6 and 153 of the 1946 Constitution.

Applications for concessions must include, among other items, the following: (1) Proof of corporate registration with the National Department of Commercial Registry, and authority to act as a "mining concern," (2) a designation of the specific minerals to be mined, (3) a plan for economic development of the deposit, (4) proof of adequate financial backing, and (5) a description of the site and easements. When the workings are to be located within a "frontier belt," permission from the Special Commission on the Frontier Belt must be filed along with the regular application. If the application is denied on the grounds of public policy or because of conflict with other interests, the Government will indemnify the applicant for expenses incurred in prospecting work.

Easements for prospecting and mining purposes may be granted, not only over the property where the deposit is located, but also over the adjoining estates. Easements may be granted to provide for the construction of offices, installations, rights-of-way, collection and carrying of water, transmission of electric power, and other similar requirements. In the absence of agreement between the concessionaire and landowner, the district court is empowered to award indemnification and set annual rent.

Subject to the approval of the DNPM, various concessions granted to the same concessionaire for mining the same mineral within the same deposit may be merged in a single mining unit known as a "mining group." The concessionaire of a mining group, subject to the approval of the DNPM, may concentrate mining activities on one or several of the merged concessions, so long as the intensity of work remains compatible with the importance of the total reserves of the deposit.

The holders of concessions for adjoining mines in the same deposit may join together and form a "mining syndicate." Permission to form a mining syndicate must be obtained from the Federal Government; such permission is granted only when a showing is made that the extractive productivity of the mine will be increased.

The concessionaire must "enter" within 90 days of the publication of the decree in the Official Gazette and commence operations within 6 months of the publication date. Mining work must not be interrupted for more than 6 consecutive months, except for reasons of force majeure. Only those minerals specified in the concession may be mined. Changes in the development plan may be made only with the approval of the DNPM. The concessionaire is required to abstain from production practices which may make further use of the mine impossible, and is under the obligation to comply with other detailed regulations.

Mining and exploration concessions are forfeited for abandonment, failure to observe time limitations on commencement or resumption of work, and failure to comply with reported recommendations of the DNPM. Where fraud or error in boundary site determination has occurred, the concession may be canceled. Fines may be leveled for various infractions of concession obligations. Decisions of the Ministry of Mines and Energy to cancel or withdraw authorization may be appealed to the President.

## Radioactive Minerals

The concessionaire is obligated to report the discovery of radioactive minerals to the Ministry of Mines and Energy. The concession may be terminated if further mining would result in uneconomical use of the minerals. If radioactive material is predominant in an ore deposit, the Government may expropriate the mine.

## Fiscal Provisions

Decree 55,928 of April 14, 1965, contains regulations concerning the Government tax on mineral production under the terms of article 9 of Law 4,425 of October 8, 1964. A 10-percent tax is levied on the value of all minerals except coal. Values are calculated by the Department of Internal Revenue of the Ministry of Finance in consultation with the DNPM. A schedule of values is to be published in the Official Gazette semiannually. The values, computed in foreign currency, are to be the average FOB export price less 40 percent at the port of shipment. If there are no exports during the 6-month period, the value is to be calculated on the average wholesale price of the product sold in the principal consumer markets of Brazil during the same period, less 40 percent. Taxes on coal are 8 percent of the official sales prices set by the National Coal Plan. The owner of the surface is entitled to a participation tax (royalty) of 10 percent of the Government mineral tax.

## Petroleum

Law 2004 of October 3, 1953, created a Government monopoly in Petroleo Brasilero S.A. (Petrobras).[4] The supervisory agency is the National Petroleum Council of the Ministry of Mines and Energy. The Council's responsibilities include supervision of production, foreign and domestic trade, refining and distribution of petroleum and other fluid hydrocarbons including natural gas. Oil shale was brought under the Government monopoly by Resolution 1-65 of February 23, 1965.

Existing petroleum concessions, pipeline and tanker facilities, and refineries in operation in October 1953 or authorized before June 30, 1952, are excluded from the monopoly but may not be renewed on the expiration of their term. The Petrobras monopoly established by Law 2004 has apparently rendered the Brazilian statutes relating to private concessions inoperative. Prior to the enactment of the Petrobras Law of 1953, both the Petroleum Law of 1941 and Decree-Law 1985 of 1940 (General Mining Code, article 9) provided for the granting of exploration and exploitation concessions to private individuals.

Originally ownership of Petrobras stock was completely in the hands of the Federal Government. At present others may hold stock, although the

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[4]See also (1) Decree-Law 538 of July 7, 1938, organizing the National Petroleum Council as a supervisory agency, (2) the General Mining Code, Decree-Law 1,985 of January 29, 1940, the provisions of which govern petroleum when not in conflict with the Petroleum Law, and (3) the Petroleum Law, Decree-Law 3,236 of May 7, 1941, exclusively for regulation of petroleum activities.

Government must always possess 51 percent of the voting stock. Stock may be sold only to Brazilian individuals, who are not married to foreigners under a community property agreement that would permit transfer of rights arising from the marriage, and to Brazilian companies, whose shareholders must be of Brazilian nationality. The corporation may organize subsidiaries to carry out particular purposes, but the same restrictions as to control and nationality must be observed.

Petrobras is exempt from any Federal taxes and from import duties. The royalty payable by the company to the States and Territories is 5 percent of the value of production, 20 percent of which the States and Territories must distribute to the municipalities involved, in proportion to their production. The State or Territory may participate up to 20 percent of the capital of the subsidiary which discovers petroleum in its area.

# CHILE

## Controlling Statutes

The Mining Code of Chile is contained in Decree Law 488 of August 24, 1932; the regulations are Decree 2228 of December 21, 1932.[1] Concessions to work most minerals are granted under this Mining Code.

The basic copper statute, Law 11,828 of March 5, 1955, has been amended by Law 16,425 of January 25, 1966, and by Law 16,464 of April 25, 1966, compiled in Law 16,624 of May 15, 1969.

The state owns all minerals, whether or not it owns the surface. Article 4 of the Mining Code reserves to the State all deposits of guano, petroleum and natural gas, nitrates and analagous salts, and iodine. Article 6 of Law 6,482, of January 4, 1940, reserved calcium carbonate, phosphates, and potassium salts found in public or Government lands and municipally owned lands. Deposits of radioactive materials may be explored and exploited only by the Chilean Commission on Nuclear Energy or by state enterprises.

Law 9,618 of June 19, 1950, created the Empresa Nacional de Petroleo (ENAP), the state-owned petroleum monopoly. Exploration for and development of all hydrocarbons, including petroleum, has been a state monopoly since the enactment of Law 4,109 of December 23, 1926.

The state reserved the right to import, distribute, and sell petroleum and its derivatives in Law 5,724 of May 16, 1932.

## Mining

### Exploration Concessions

The Mining Code permits unrestricted prospecting for minerals on lands which are not cultivated or enclosed; otherwise, permission of the occupant is required. Exploration of state or municipal lands requires permission of the governor or mayor. An application for an exclusive exploration license, submitted to the district judge, must show the measurement and boundaries of the surface area to be explored, the minerals sought, and the name of the surface owner of the property. It must be accompanied by payment of a nominal fee. Following publication, interested parties may record objections to the proposed exploration concession. If no objections are upheld, the concession is granted. The judge's order describing the surface area is then recorded in the Register of Discoveries of the Conservator of Mines of the appropriate district.

Exploration concessions are granted for a maximum term of 2 years. Activity must commence within 6 months or the concession is subject to termination. Surface owners must be compensated for damages due to exploration activities. The holder of an exploration concession has an exclusive right to a mining or exploitation concession in the area covered.

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[1] For information write Servicio de Minas del Estado, Ministerio de Mineria, Santiago, Chile.

## Exploitation or Mining Concessions

Aliens and citizens, except certain Government officials, are eligible for exploitation or mining concessions. A concession is a multiple of claims (pertenencia) of not less than 1 nor more than 5 hectares for metals and precious stones, and not less than 1 nor more than 50 hectares for other minerals. The minimum width of a concession is 50 meters.

After discovering minerals, an application is submitted to the appropriate district judge stating the name, civil status, profession, nationality, and domicile of the applicant; the physical features at the site of the discovery; the name of the property; the type of mineral and the form of the deposit; the number of surface units requested; and the area that is included. By order of the judge, the registration is effected in the Register of Discoveries within 60 days. Within 300 days the applicant must erect location monuments, file a plan, and request a survey of his claim, after which the application is posted for 2 weeks in the office of the court clerk. Two publications within 40 days precede the survey by an engineer of the state mining service. When approved and recorded in the property register of the Conservator of Mines, this survey constitutes the title to the mine.

The holders of mining concessions are entitled to certain easements which the surface owner must allow in order to facilitate mining operations.

## Coal

The Mining Code contains special provisions concerning coal mining concessions. Applications must be submitted to the President of the Republic, and must be supported within 6 months by satisfactory evidence of financial ability. The President's order granting the concession fixes a date before which work must begin and the amount of royalty, which is not more than 2-1/2 percent, that the concessionaire must pay to the surface owner of the property.

## Gold

Applications for concessions to explore for and exploit gold deposits are subject to the provision of the Mining Code. The President is authorized to reserve gold placers to be worked by the state, or to be granted to individuals under special conditions.

## Nitrates

Transfer of any nitrate claim is reserved to the state, and Law 16,624, article 10 governs the extraction of such material. In 1968 the Anglo-Lautaro Nitrate Corporation and the Government-owned Empresa Salitrera Victoria S.A. were combined in a new mixed company, Sociedad Quimica y Minera de Chile, S.A., in which Anglo-Lautaro held 67.5 and the Government 32.5 percent interest. This merger, in effect, consolidated all nitrate and iodine operations in Chile.

## Guano and Phosphates

Concessions to guano deposits may be granted by the Ministry of Agriculture. At present, all guano deposits are worked by the Sociedad Chilena de Ferrilizantes Ltda. Phosphates, lime, and potassium salts are governed by the Ministry of Agriculture under Law 6,482. Concessions for the exploitation of these materials may be granted for such a time period as specified in the individual contract.

## Copper

The large-scale copper mining law of May 1955 (Law 11,828) was amended in 1966 by Laws 16,425 and 16,464. Enterprises producing more than 75,000 metric tons of blister copper are categorized as "gran mineria" or large-scale companies, and are subject to a single 52.5-percent tax on basic production. An additional tax is levied on production exceeding the fixed base.

The state-owned Copper Corporation (Corporación del Cobre), established in 1955, has broad supervisory and regulatory powers over copper production, sales, and foreign trade. Gran minerias are required to furnish detailed operation reports to the corporation.

The Copper Corporation is directed by a board headed by the Minister of Mines. In addition to administering in detail the powers of the Copper Corporation, the board authorizes copper exports and imports of mining equipment, passes upon sales and transportation contracts, and negotiates sales for the producing companies. In time of world crisis or serious disturbance in the world copper market, the President has the power, upon corporation approval, to decree a monopoly over copper exportation. During April 1967 the Government purchased a majority interest in the El Teniente mine and plants previously wholly owned by Kennecott Copper Corp. In 1969 steps were taken toward nationalization of both of Anaconda's major subsidiaries in Chile. All assets of these subsidiaries were transferred to two mixed companies on January 1, 1970. On that date the Government purchased 51 percent of the stock of the new companies. The Chilean Government is obligated, to purchase the remaining shares during the period 1973 through 1981.

## Taxation

Mining corporations and partnerships, except the gran minerias, are taxed under Title IV of the Income Tax Law. The rate for a corporation (sociedad anónima) is 30 percent, and for an individual or partnership (sociedad de personas) 20 percent. A surcharge, amounting to 30 percent of taxable income, may be applied to foreign-owned enterprises.

## License Fees

Concession holders are required to pay a nominal yearly license fee (patent). Failure to pay the license fee annually in March is cause for auctioning the concession, at the direction of the district judge.

## Petroleum

Petroleum resource development is a state monopoly under Law 4109 of December 23, 1926. The Government company, Empresa Nacional de Petroleo (ENAP), operates under Law 9618 of June 19, 1950, which excludes foreign operators except under contract for geological and geophysical exploration and drilling.

# COLOMBIA

## Historical Background

In consequence of historical development, certain minerals have passed into private ownership in some areas (an unusual situation in Latin America); others are owned by the Government and administered on regalian principles.

During the colonial period and the first 40 years of independence, the regalian theory of title to the subsoil prevailed in Colombia. All mines belonged to the national state (Mining Ordinance of New Spain, 1763; Decree of Simon Bolivar, Oct. 28, 1829). This principle was maintained until 1858, when the Republic was organized in federal form. The Constitutions of 1858 and 1863 reserved only the emerald and rock-salt mines as property of the Nation; the federated States were free to legislate with respect to all other mineral substances, and considerable State legislation followed. Most of these laws claimed ownership of gold, silver, platinum, and copper for the local State but left other minerals to be disposed of by the owner of the soil. Thus, there prevailed in Colombia a mixed system for minerals: The regalian theory and the theory of private titles; in addition, one State, Cauca, granted all minerals to the landowner.

By Decree of October 28, 1873, the central Government reserved for itself the title to all minerals that existed or that should be discovered in unappropriated lands.

In 1886 the country was reorganized in the form of a single central Republic, and by the constitution of that year the Nation recovered for itself the mineral rights that had belonged to the federated States, leaving unaffected, however, rights previously acquired by private owners. The minerals that have belonged to the Nation since 1886 are:

1. Emerald and rock salt.

2. Deposits of petroleum, iron, coal, sulfur, asphalt, and, in general, all nonmetallic minerals that exist in unappropriated lands or in lands wherein the surface title passed out of the ownership of the State after October 28, 1873 (Fiscal Code).

3. Gold, silver, platinum, copper, and precious stones.

Mines that may belong to private owners are as follows:

1. In gold, silver, platinum, and copper when the owners hold adjudicated titles issued by the State;

2. In petroleum, iron, coal, sulfur, asphalt, and, in general, all nonmetallic mineral deposits that exist in lands where the surface title passed out of ownership of the State before October 28, 1873 (Fiscal Code).

## Mining

The Mining Law of 1967, Law 60 of December 26, 1967, and the President's Decree 1163 of June 19, 1967, are the major laws governing mining in Colombia.[1] However, there are numerous older laws and decrees which remain in effect, subject to the provisions of the new laws. Mining of veins of precious metals and copper is governed by the Mining Code, Law 38 of 1887. Development of most other minerals is governed by Decree 805 of March 5, 1947, as amended by Decree 2419 of November 20, 1958.[2]

The new Mining Law of 1967 gives broad powers to the Ministry of Mines and Petroleum over concession grants, terms, and production requirements for all state-owned mineral deposits except precious metals, rock salt, and hydrocarbons.[3]

Foreign corporations may carry on business through a domestic branch or subsidiary. Mining concerns pay only the basic tax on net profits under Law 81 of December 20, 1960, and subsequent regulations. Under Decree 262 of February 23, 1968, mineral exports after January 1, 1969, will be given a 15-percent tax credit.

### Mining Code of 1887

Gold, silver, and platinum, unless found in the beds or banks of navigable rivers, and copper minerals are adjudicable; that is, the central Government can grant title and possession to applicants who comply with the formalities of the Mining Code of 1887. The discoverer of a mineral deposit notifies the chief administrative officer of the municipality where the deposit was found. Within 90 days he must denounce the property before the Governor of the Department, who orders that it be surveyed and possession delivered to the discoverer, to whom the Governor then issues a "title of adjudication" in the name of the state.

In each claim or title that covers a vein or lode, the maximum area that may be included is a rectangle 1,800 meters long by 240 meters wide; in placer claims, the area may be a rectangle of 2 by 5 kilometers, or a square 3 kilometers on each side. Nevertheless, by means of separate notices, denouncements, and claims, one person can acquire an unlimited number of claims. To keep title, he must pay a small annual tax and do exploration or exploitation work.

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[1] The President's Decree 1163, which now constitutes the regulations under the new law, was promulgated prior to the passage of Law 60 of December 26, 1967. It contains the details of the adjudication process for mining claims.

[2] Development of uranium is governed by Decree 2638 of 1955. Special regulations relating to emeralds are contained in Law 40 of 1905 and Law 145 of 1959 as supplemented by the following: (1) Decree 545 of May 4, 1960, (2) Decree 293 of February 14, 1964, (3) Decree 585 of 1955, and (4) Decree 912 of June 21, 1968.

[3] For information, write Division de Minas, Ministerio de Minas y Petroleos, Bogota, Colombia.

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The maximum area that can be included in each contract for mines of precious metals in the beds or in the banks of navigable rivers is 15 kilometers in length (along the river) by 2 kilometers in width. One person, using his right to enter into five contracts, may include a maximum area of 75 kilometers in length by 2 kilometers in width. The Government requires a royalty varying between 2 and 20 percent of the crude production from this type of mine according to the richness of the deposit (Law 13 of 1937, Law 85 of 1945, Law 81 of 1946, Decree 805 of 1947). The industry of mining precious metals is exempt from excess profits (patrimony) tax.

## Decree 805 of 1943

Minerals not subject to the Code of 1887 but which belong to the state may be exploited by private parties under concession contracts with the Government. The maximum area for a claim that can be included in each contract for iron, sulfur, coal, asphalt, and other nonmetallic minerals is 5,000 hectares. One person may enter into five contracts. Previously the Government collected for the exploitation of mines of this type a royalty of 5 percent of the crude product, but Decree 2514 of 1952 reduced this royalty to encourage exploitation of this class of minerals.

The general features of these contracts can be summarized thus: The concession allows a period of exploration of 2 years, which can be extended for 6 months more; a period for installation of machinery of 1 year, which may be extended for 2 additional years; and finally a period of exploitation of 30 years, which may be extended for 10 years more. When the contract terminates at the expiration of its term or is voided, title to all the property that the contractor may have installed passes to the State, which is declared to have a reversionary title. Decree 805 of 1943 regulates the procedure and related matters with respect to contracts of this type.

## Special Mining Laws

The following mines or mineral substances are governed by special provisions:

1. The exploration, exploitation, and sale of emeralds are governed by Law 40 of 1905 and Law 145 of 1959. By Decree 585 of 1955, exploration of emerald mines can be carried out only after permits have been granted by the Minister of Mines; exploitation requires special contracts with the Government. Decree 912 of June 21, 1968, in supplementing Law 145 of 1959, provides for the creation of the Colombian Emerald Enterprise which has the following functions: (1) To explore, exploit, and administer the deposits of emeralds, other gemstones and semiprecious stones, beryl, and other minerals found in the national reserve, (2) to acquire directly or by transfer, adjudication, grants, leases, concessions, and permits of exploration and exploitation of the above mentioned minerals in all regions of the country, as well as privately owned deposits, and (3) to organize domestic and foreign trade of the emeralds and other precious and semiprecious stones, beryl, and minerals obtained.

2. Under Decree 2638 of 1955, mines of uranium and other radioactive substances may be exploited only by the Government or through special contracts with the Government.

3. Development of salt mines is reserved to the Government and is administered under the Fiscal Code.

## Mining Law of 1967

The principal features of the Mining Law of 1967 are (1) minerals are to be processed in the country, whenever possible, and special preference is to be given to meeting domestic needs (article 1), (2) the mining laws in effect establish only minimum economic and financial standards and the Government, with prior agreement of the affected parties, may stipulate royalties and shares, and may restrict the limits of exploration and exploitation (article 3), (3) the Ministry of Mines and Petroleum must conduct investigations to determine royalties, participation, and benefits before awarding mineral rights (article 3), and (4) the Government may declare any part of the country to be a natural reserve to stop development pending investigation by the Ministry of Mines and Petroleum.

With the exception of emerald mines, deposits of precious metals, salt mines and hydrocarbons, deposits may be adjudicated for exploitation, development, and operation by two alternative systems: (1) The Ministry may award them to other official entities (e.g. Institutio de Fomento Industrial) which may assume total responsibilities, or which may form mixed enterprises, or (2) the Ministry may lease them to private entities, through a process of public bidding. Lease contracts with private entities shall have a term of 30 years from the date on which production begins, and be renewable for an additional 10 years if the lessee increases the royalties to the Government. The lessee is under the following obligations: (1) To carry out exploration work for a period not exceeding 12 months, (2) to employ adequate economic and technical systems for extraction, (3) to carry out the stipulated amount of domestic processing, and (4) to pay as royalties at least 2 percent, but not more than 20 percent of the total annual production.

The choice of which system is to be adopted is in the discretion of the Ministry, which must consider which system would produce the most fiscal income and development. If given deposits are not suitable for adjudication by either of these methods, the Government at its discretion may adjudicate them in the regular manner in accordance with the existing law.

Decree 292 of March 1, 1968, gives the Ministry of Mines and Petroleum authority to set royalties on the mining of base metals. Operations which must pay royalties are those with an annual production level of (1) 30,000 tons of native mercury ore, (2) 150,000 tons of iron ore, lateritic nickel, titanium, or bauxite ore, and (3) 100,000 tons of other classes of metal ores including sulfurous mercury and nonlateritic nickel. Royalty rates range from 3 to 8 percent depending upon rate of production. The decree also concerns plans of development, amount of processing to be carried out locally, and preferential treatment to national needs.

As an incentive to development, the Colombian Government issued Decree 262, on February 23, 1968, which states that crude and processed mineral exports will receive a 15-percent tax credit after January 1, 1969, when prior permission is received from the National Economic Policy Council in consultation with the Ministry of Mines and Petroleum.

## Petroleum

Law 37 of 1931, as amended, governs the development of petroleum resources.[4] Decree 1056 of April 20, 1953, codified the Petroleum Code.

Colombia is divided into western and eastern zones, the boundary being the Eastern Cordillera Range. Zone determines many of the terms of concessions.

Foreign governments and companies are eligible for concessions, but recourse to diplomatic action must be waived. In awarding concessions, preference is given first to an applicant who has carried out surface reconnaisance work, second to the owner of the land, third to concessionaires working in the vicinity, and fourth to the applicant requesting the largest area.

Surface reconnaissance may be carried out on public lands without special permission. On private land, the owner must be notified of planned operations and compensated for any damage to his property.

### Exploration/Exploitation Concession Contracts

A single concession conveys rights to explore for, develop, and produce petroleum resources. It includes an initial stage called the exploration permit.

The term of an exploration permit is 3 years in the west, renewable for 3 years, and 4 years in the east, renewable for 4 years. The maximum area of an exploration permit is 25,000 hectares in the west and 1 million hectares in the east. There is no limit on the number of permits or maximum area which may be held by one concessionaire. Minimum drilling requirements are specified, ranging from 6,650 feet during the initial term, to 13,120 during each year thereafter. Drilling must commence at least 5 months prior to the end of the initial term. To guarantee performance, a sum amounting to US$1 per hectare, but not less than US$15,000, must be deposited.

The exploitation stage begins automatically at the end of the exploration period, or earlier if oil in commercial quantities is found. The term of an exploitation concession is 30 years in the west and 40 years in the east. During the first year of the exploitation stage, 50 percent of the concession area must be relinquished, subject to minimum area requirements. Relinquished areas are offered by an auction system.

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[4] Law 10 of March 16, 1961, is one of the more important of the approximately 82 laws, decrees, and resolutions which pertain to petroleum resource development.

A concession may be terminated if (1) royalties or taxes are not paid, (2) production is not commenced within the periods fixed in the concession or is suspended for more than 120 days without permission, (3) a cooperative plan of production is rejected, (4) arbitration is refused, or (5) the minimum annual investment is not made.

## Financial Provisions

During the exploration stage, surface rentals are payable, ranging from US$0.20 per hectare in the first year to US$3 in the fifth year in the west. In the east, rentals range from US$0.10 per hectare to US$1 during the sixth year. Rentals are reduced by 50 percent if drilling has been in progress for at least 300 days in the year.

Royalties on oil produced from public lands are 11-1/2 percent in the zones east and southeast of the crest of the Eastern range, except for concessions developed before 1971, in which case royalties are 7 percent for the first 10 years. Elsewhere in the country, including territorial waters, royalties are 14-1/2 percent on future concessions. Production of privately owned oil is subject to a production tax, amounting to 6-1/2 percent in the east and 8-1/2 percent in the west.

Concessionaires are given a depletion allowance amounting to 10 percent in the west, less royalty or tax payable, and limited to a maximum of 35 percent of net income. In the east, the allowance is 28 percent but not more than 50 percent of net income. Concessionaires in the west are given an additional 15 percent allowance to the extent such amounts are reinvested in exploration of nonproducing properties.

Concessionaires are exempted from all municipal and State taxes, and export taxes for a period of 30 years, and from import duties on machinery and equipment.

# ECUADOR

## Controlling Statutes

The basic law governing mining is the General Mining Law No. 3 of February 5, 1937. The Law on Gold Washings, No. 4 of February 5, 1937, is the basic law governing alluvial deposits. The General Mining Law of September 19, 1961, Decree 2671 of December 1, 1965, and Decree 1208 of October 7, 1966, supplement the basic laws.

The basic laws governing petroleum development are the Petroleum Law of August 6, 1937, and the Petroleum Law of August 19, 1961, as amended by Decree No. 1464 of June 30, 1965, Decree No. 1208 of October 7, 1966, and Regulation No. 1844 of October 28, 1966. It has been reported that a new petroleum law is being considered to replace the 1937 law.

## Administration

The administrative body for both mining and petroleum is the Direccion General de Minas e Hidrocarburos.[1] The Ministro-Juez de Minas has the power to grant concessions and permits, to levy fines and forfeitures, and to make inspections and other decisions under the law. Concessionaires may appeal adverse decisions of the Ministry, usually made by the tribunal of the Ministry called the Ministerio-Juzgado de Minas, to the Council of State.

## Mining

The General Mining Law of February 5, 1937, provides that all minerals found beneath the surface are the property of the State, irrespective of surface ownership.

Construction materials are available for "common exploitation" although the State may grant concessions for these substances. Mineral resources other than hydrocarbons are divided into two classes: Lodes, veins, beds, or impregnated deposits (class 1); and alluvial or placer deposits formed generally in the beds of streams (class 2). The mining industry is declared a public utility by law.

Under Decree 1208, only those firms and individuals who have the necessary technical and economic capacity to complete a development program will receive exploration and exploitation rights. Concession application rights are not assignable.

### Concessions for Prospecting and Exploration

The Ministro-Juez de Minas is authorized to grant permission for prospecting and exploration of mining zones. Each concession is limited to 20 pertenencias (claims) in a solid block, exclusive of existing denouncements. The

[1] For information, write Direccion General de Minas e Hidrocarburos, Ministerio de Industrias e Comercio, Quito, Ecuador.

area of a claim for mines in the first category (lodes) is that of a rectangle 200 by 500 meters, equal to 10 hectares. For mines of the second category (placers) a claim has an area of 25,000 square meters, measured in any form specified by the claimant along the length of the riverbed in accordance with the placer mining law (Decree No. 4 of February 5, 1937).

Prospecting and exploration concessions have a maximum duration of 180 days, but may be extended for an additional 90 days.

Concessions are prohibited within certain areas: (1) Towns, (2) gardens, cultivated fields, and so forth, (3) enclosed or permanently cultivated areas, unless compensation is paid, (4) within specified distances of railroads, public roads, buildings, and so forth, (5) within specified distances of fortifications, and (6) within 500 meters of canals, aqueducts, and so forth.

Mining concessions may be obtained from the government by (1) denouncement and (2) contract.

## Denouncement Concessions

Denouncement concessions are limited to 20 pertenencias for 20 years for lode claims and 15 years for placer claims.

A discoverer of minerals may submit an application for a denouncement to the Ministro-Juez de Minas, with a receipt signed by the Direccion General de Mineria y Petroleo showing the date and hour of the filing. The application must include the geographical location, description, plan of the mine, names of the owners, samples of the mineral, and certificate of payment of the first annual rent. Documentation evidencing economic and technical capacity should be presented with the application.

Article 49 directs issuance by the Ministerio-Juzgado de Minas of a decree certifying the application; the denouncement is then published three times in the Registro Oficial, at 10-day intervals.

Holders of denouncement concessions are required to begin work on the discovered lode or vein within 90 days. The minimum requirement is a shaft 5 meters deep or a horizontal gallery of the same dimensions in the direction of the vein to establish its existence and characteristics. If this work is approved by the Ministro-Juez de Minas, the holder's registration will be deemed confirmed.

Under Decree 1208 a person, who discovers any indications of mineral deposits but lacks the required capacity to exploit them has the right for 10 years to receive 3 percent of the net benefits from any exploitation concession later granted on the discovered location.

## Contract Concessions

These concessions are granted to whomever the State decides is best qualified to carry out mineral development. A contract concession conveys an exclusive right to develop a specified area.

Contracts may be made for an optional period of not more than 1 year to allow time for agreement on the definitive terms under which the concession, if signed, will operate. The terms of the concession are determined by mutual agreement; however, the exploration period of the concession cannot exceed 4 years and the term of the concession is 30 years, subject to an extension for a like period.

Decree 1208 limits the size of a mining exploration concession that may be granted in any one contract to 100,000 hectares. It further states that, no matter how many exploration contracts the concessionaire may have, when he enters the exploitation period, he may retain no more than 10,000 hectares.

Applications must be filed with the Ministro-Juez de Minas and approved by the Direccion General de Mineria y Petroleo, which investigates and reports upon all applications.

## Gold-Bearing Placers

Under the Law on Gold-Washings and Decree 1208, only those individuals and firms presenting evidence of economic and technical capacity may extract gold from alluvial deposits under concessions. Any person may engage in gold washing in free zones after obtaining a 1-year permit for a fee of 10 sucres.

In the case of placer gold, no exploration concession larger than 10,000 hectares or smaller than 50 hectares may be granted. Previously the upper limit was 200 square kilometers and the lower limit was 50 square kilometers. In addition, the new Decree limits gold placer exploitation concessions to those areas that have been surveyed and measured.

All concessionaires are obligated (1) to employ Ecuadoreans to the extent of 85 percent of the labor force and 10 percent of the administrative staff, (2) to submit to the Government reports of the work accomplished, types and quality of minerals found, topographical, geological, and mineralogical data, and other data that may be required to demonstrate the results of the exploration and exploitation, (3) to submit to the Government, on demand, economic and technical data related to the concession, (4) to keep books in the Spanish language in accordance with the requirements of the commercial code of Ecuador, (5) to develop the concession utilizing adequate and efficient machinery for that purpose, (6) to open to public use any roads that the concessionaire may construct, (7) to name a general manager with power of attorney, (8) to maintain the boundary monuments of the concession, and (9) to surrender to the Government all machinery and installations, in case of forfeiture or abandonment of the concession.

The following rights of the Government are specifically included in all concession contracts: (1) To supervise the efficiency of exploitation and demand the use of machinery adequate for the mine, (2) to examine the accounts of the concession, (3) to use without charge the means of communication of the concessionaire when those of the state may be interrupted, granting reciprocal privileges to the concessionaire, (4) to see that roads constructed by the concessionaire are open to public use as soon as they are completed, and (5) to supervise the operations of the concessionaire and require him to comply with all of the terms of the contract.

Concessions may be terminated for the following reasons: (1) Deliberate obstruction of Government supervision and inspection, (2) breach of applicable laws and regulations, (3) abandonment of the concession, and (4) failure to start exploitation within 5 years from the date of the grant.

A concessionaire can transfer his concession to one or several companies or persons after giving notice and obtaining authorization from the Ministry; otherwise, an attempted transfer would cause forfeiture of the concession. One cannot own, control, or acquire title by transfer to more than 20 pertenencias.

## Fiscal Provisions

The license fee for an exploitation concession during the first 3 years prior to active exploitation is 50 sucres (1 sucre - 100 centavos = US$0.0556) per year per pertenencia, except in the case of contract concessions where the amounts are fixed in the contract. When a mine remains idle, the license fees are 100 sucres per pertenencia during the first such year, 500 sucres the second, and 5,000 sucres the third; thereafter the concession is subject to cancellation.

All concessionaires (denouncement or contract) must pay from the time the exploitation phase begins, 6 percent of the value of the monthly production of raw ore. Denouncement concessionaires, once payment of these royalties begins, are exempted from the payment of the 50-sucre license fee. The royalty percentage may be altered by mutual agreement of the parties, but may be decreased only for justifiable cause acceptable to the Chief Executive. In lieu of all or part of the 6 percent royalty, a concessionaire may agree to construct specific public works.

The Mining Law requires concessionaires to pay taxes of general application including income taxes and taxes on sales made by company stores.

The importation of capital goods and equipment for use in mining exploration and exploitation is duty-free for different periods depending on the mineral class and concession type: 5 years for denouncement concessions and 15 years for contract concessions of class 2 minerals; 10 years for both denouncement and contract concessions for class 1 minerals; and 15 years for any contract concession of 30 years' duration. An exemption from the tax on operating capital is granted for the same periods of time.

## Petroleum

The Constitution of May 25, 1967, provides that deposits of oil and gas are the property of the State and are subject to disposition only under the terms of the Petroleum Law.

The petroleum industry in all its branches (exploration, exploitation, storage, refining, and transportation) is declared to be a public utility. The industry is granted the right of eminent domain, subject to the provisions of the General Mining Law.

By Decree No. 780 of May 28, 1943, all mine and oil concessions that have reverted to the State through voluntary relinquishment or through termination become areas of national reserve.

Concessions may be granted to competent foreign individuals and to corporations domiciled in Ecuador, but not to foreign governments or to corporations they control. Public officials are specifically prohibited from acquiring interests in mines.

Where there is no conflict, the Petroleum Law states that petroleum concessions are subject to the general provisions of the Mining Law. The two general classes of petroleum concessions are contract and denouncement.

## Contract Concessions

Any technically and financially qualified person, natural or juridical, may apply for a contract for exploration or exploitation of petroleum. Evidence of technical and financial capacity must be presented with the application. The required contents of the application are (1) map, (2) preliminary description of the area, and (3) a bond.

Decree 1208 of October 3, 1966, provides that the Ministerio-Juzgado de Minas, once it has accepted the application for a concession, will notify the applicant so that within 30 days he can deposit in the Central Bank of Ecuador, in cash, the sum of 1 sucre for each hectare of the area. If the contract is not granted, the guarantee will be returned.

Once the contract has been granted, the concessionaire, within 30 days of the date of signature, must make a further guarantee equivalent to 15 percent of the investment obligations which he had promised to make during the period of exploration.

For concessions granted in the eastern or "Oriente" region, special bonds may be stipulated by mutual agreement between the parties. The exploration bond obligates the concessionaire to carry out the agreed exploration program but may be canceled when the area is proved to be nonproductive. The bond is returnable at the end of the exploration period once exploitation has started or at any time during the exploration period when it is proven that an amount equal to the value of the bond has been invested in operations. During the exploitation period, bonds of various other types are required.

(1) Contract concessions (exploration phase).--The exploration period for concessions acquired by contract is 5 years but may be extended for a period of 3 years in the "Oriente" region. The minimum area for a contract concession is 100 "estates" (fundos petroliferos) or 400 hectares; the maximum area is 50,000 hectares (but may be increased with approval of the Attorney General). For administrative purposes, contract concessions are to be consolidated in groups of 100 fundos (400 hectares) and must be marked on the ground. In the "Oriente" region the area limits for concessions may be varied at the Government's discretion.

(2) Contract concessions (exploitation phase).--Contract concessionaires may begin exploitation at anytime during the period of exploration, after giving notice to the Government and filing required plans, geological maps, and descriptions of the area to be exploited. There is no requirement to surrender part of the concession area or change from exploration to exploitation status, nor is there any increase in surface taxes or rents.

A contract concession for exploitation may be granted for 40 years, exclusive of the exploration period, and may be extended for an additional 10 years.

Concessions by Denouncement

In general, a denouncement concession provides the same rights as may be acquired by contract but is limited to smaller areas and is of shorter duration.

The exploration period for concessions acquired by denouncement is 2 years but may be extended for an additional year in the "Oriente" region. A denouncement concession for exploitation may be granted for 20 years, exclusive of the exploration period, and may be extended for an additional 5 years.

The minimum size of a concession acquired by denouncement is 4 hectares, called an "estate."

A petroleum concessionaire is forbidden to transfer his concession to third parties without approval of the Ministry. The Ministry retains the right to (1) supervise work including location of wells, pumps, pipelines, refineries, and storage tanks, (2) promulgate administrative regulations, and (3) determine when the exploitation phase of a concession begins.

Contract concessions must stipulate, with respect to the exploitation phase, the minimum annual development work required and the number of years during which further investment is mandatory.

Contract and denouncement concessionaires exploring for or producing petroleum must locate wells at least 100 meters from the boundaries of concession areas. At the Government's discretion, concessionaires may be obligated to negotiate a cooperative plan (approved by the Ministerio-Juzgado de Minas) for joint exploitation, when a structure is found to embrace two or more concession areas.

Restriction of production to a rate that is less than one-third of the productive capacity of any well is prohibited. Should production be maintained below that level, royalties would nevertheless be calculated on a third of potential. Disputes over productive capacity are to be resolved by appointment of appraisers to represent each party in arbitration.

Concessionaires cannot increase production at their own election but must conform to the quotas determined by the technical staff of the Ministry. Quota disputes are settled through arbitration.

The Government may impose conservation measures or forbid operations that threaten damage to an oilfield. Provisions of the General Mining Law regarding employees and workers also apply to similar activities in the petroleum industry.

Except where a minimum number of hectares is fixed in a concession as not subject to relinquishment throughout the term of the concession, the Government is required to accept at any time the return of lands which a concessionaire finds not suitable for development as a result of his investigation work. Notice of abandonment, tendered in writing, is required; at that time possession is returned to the state and the concessionaire is excused from further payment of the surface tax on the surrendered areas. The surface tax and performance bond are then reduced in proportion to the retained area.

On abandonment or cancellation of a concession during its exploratory phase, the concessionaire may withdraw all his material and equipment. When abandonment or cancellation occurs during the exploitation phase, all production equipment must be left in place and passes without compensation to the State. In both instances, the concessionaire forfeits his performance bond. However, if the concession terminates because improbability of production or profitable operation has been duly proved, or due to war or internal disturbance, the concessionaire may recover his equipment (except pipelines) within 6 months of giving notice of abandonment. This period may be extended if the concessionaire is prevented, without his fault, from completing the withdrawal of his material within that time. The Government may, however, within the same period acquire all such equipment upon compensating the concessionaire. In the case of involuntary abandonment so occasioned, the concessionaire's performance land will be returned to him.

Causes for termination include (1) failure to invest minimum agreed amounts, (2) failure to begin exploitation when required, (3) unauthorized suspension of production for more than 180 days, (4) trespass on the property of others, and (5) unauthorized subcontracts or attempted transfer of the concession. An administrative finding of forfeiture requires advance notice. If the concessionaire's operations are suspended in consequence of force majeure, his obligations are similarly suspended and the concession correspondingly extended.

## Fiscal Provisions

Concessionaires (both contract and denouncement) must pay income and sales taxes or their equivalents, as well as all other types of taxes.

The petroleum law as amended by Decree 2940 of December 28, 1965, prescribes that, for the duration of the respective term, holders of concessions in the exploration and exploitation periods are exempted from payment of customs taxes as well as those not expressly fixed by law.

The contract concessionaire is required to pay annually, during both the exploration and exploitation phases, a surface tax (canon) of 20 centavos per hectare during the first 2 years, 40 centavos during the third, 80 centavos in the fourth, and 1 sucre in the fifth and subsequent years. In the "Oriente"

region surface taxes may be established by agreement. During both exploration and exploitation, a denouncement concessionaire must pay an annual tax of 30 sucres per "estate."

In addition, the concessionaire must compensate the surface owner for any damage to his property.

The royalties payable to the Government range from 5 to 11 percent of net production and are based on the distance from the gathering center to the nearest port of shipment.

The royalty rate is 9 percent on production from lands submerged by territorial waters.

The Government may demand royalties either in cash or in kind; if in kind, the royalty may be collected at the collection center or at the port of shipment. If royalties are demanded in cash the price is to be determined by the Government, taking into account the following: (1) the average quotation during the previous quarter for fuel oil and gasoline in the world market, plus transportation costs to the port of Guayaquil, (2) the actual cost of production at the places of production, as determined by taking into account the costs of administration and management of the enterprise and a reasonable profit, and (3) the average of the prices for fuel oil and gasoline obtained in the Ecuadorian market during the previous quarter.

Instead of paving the prescribed royalties, the contract concessionaire may agree to perform work of other sorts, such as construction of roads, railroads, and bridges. The same privileges are available to denouncement concessionaires.

The Government determines the price of petroleum products destined for consumption in the country, based on the cost of production plus a reasonable profit under Decree No. 1464 of June 30, 1965.

## Pipeline Transportation

All concessionaires have the right to construct pipelines to carry their own production. Concessionaires whose production is not sufficient to justify a private pipeline may jointly construct a common pipeline for the exclusive service of their respective concessions. Companies not engaged in petroleum production may build common carrier pipelines by special arrangement with the Government. Plans for proposed pipelines require the approval of the Direccion General de Mineria y Hydrocarbons and the Ministro-Juez de Minas.

A pipeline concession is for a term of 30 years, which may be extended 10 years by agreement. At the end of the concession period, the pipeline with all of its fixed and movable installations passes to the ownership of the state without compensation. This transfer applies whether the pipeline is built under special concession or by holders of petroleum concessions.

The Government reserves the right to have its oil (up to 20 percent of the pipeline capacity) carried at prevailing tariffs, minus a discount of 5 percent.

Pipeline transportation tariffs are fixed for 4-year periods by the Government, taking into account amortization of capital invested in construction, operating and administrative costs, and a fair profit as determined by comparison with similar undertakings in other South American countries.

The tax on the oil transported by a pipeline is fixed at 5 percent of the value added measured by the average rates per barrel charged by all pipelines. This value is computed quarterly.

## Refining

Holders of concessions for exploration and exploitation of petroleum may install and operate their refineries during the entire term and extension of the concession. Concessionaires may install refineries only at their own camps and at the ports of shipment of their products. Refineries that do not hold petroleum concessions may obtain a refining concession for a fixed period of 30 years; however, a bond in the amount of 15,000 sucres must be deposited in advance and remain in force for the duration of the concession.

The Government retains the right to build and operate or to contract for construction and operation of refineries for the treatment of oil acquired by royalty or any other method. The Government also retains the right to resell its royalty oil at prices no less than those at which oil is offered in the market by producers who contribute royalties.

Refineries belonging to a contract concessionaire pay an annual tax or license fee of 5,000 sucres, and refineries of denouncement concessionaires pay a tax or license fee of 1,000 sucres; other refineries pay an annual tax or license fee of 12,000 sucres.

# GUYANA

## Controlling Statutes

Guyana, formerly British Guiana, achieved independence in 1966 and is a member of the British Commonwealth. Most of the mining and petroleum legislation remains substantively unchanged. The basic mineral law and regulations governing all minerals, except bauxite, petroleum, coal, asphalt, and radioactive minerals, is Chapter 196 of the Mining Ordinance (Mining Ordinance of 1920) and Chapter 196 of the Mining Regulations (Mining Regulations of 1931).

Bauxite is covered by the Bauxite Mining Regulations, Chapter 196 (Bauxite Regulations of 1930). Radioactive minerals are dealt with under the Radio-Active Minerals Ordinance, Chapter 198 (Radio-Active Minerals Ordinance of 1947).

Petroleum exploration and development are subject to the provisions of the Petroleum (Production) Ordinance, Chapter 199 (Petroleum Ordinance of 1939) and the Petroleum (Prospecting and Winning) Regulations of 1967.

## Administration

The mining and petroleum regulations are both administered by the Commissioner of Lands and Mines.[1] Appeals from decisions of the Commissioner are provided by the regulations and are heard by the Supreme Court; a further right of appeal to the full court may be exercised. Supervision of mining operations is exercised by the Inspector of Mines of the Commissioner's office over the warden and mines officers in each mining district.

## Mining

### Prospecting License

The Commissioner or warden may issue a prospecting license, good for 2 years, to any applicant 21 years of age or over. This license authorizes the holder to prospect and locate claims on Crown land in every mining district. The holder of a prospecting license may prospect for all minerals regulated by the Mining Ordinance except in reserved areas, waters set aside for drinking purposes, building sites, and similar areas.

A prospecting license does not confer any rights to mine a claim.

### Claim License

Upon locating a claim, the applicant must within a reasonable time (not to exceed 3 months) notify the warden or mines officer of the mining district or the Commissioner and request a claim license to mine for the minerals found.

[1] For information, write to Commissioner of Lands and Mines, Ministry of Agriculture and Natural Resources, Georgetown, Guyana.

There appears to be no limit to the number of claims that may be located under a prospecting license. The area of a surface mining claim is 1,500 by 800 feet (approximately 27-1/2 acres). A river location may be no more than 1 mile long measured along the bank.

The regulations provide that the boundaries of all locations must be marked. The side lines and end lines of a surface claim are required to be parallel wherever possible, except when prior locations or natural features prevent such surface boundaries. The side lines of a river location are to be fixed at the low water mark on each bank of the river, and the end lines are to be fixed by straight lines between the corner marks.

Licenses continue in force indefinitely, provided that rents are paid annually; however, a license may be revoked by the district warden for failure to work the claim.

A fee of 48 cents must be paid for filing a claim, and G$5.00 (G$1 = US$0.50) per calendar year must be paid for each claim. A filing fee of G$2.00 and an annual license fee of G$20.00 must be paid for each river location.

A claim license confers upon its holder the right to the use and enjoyment of the surface included within the boundary lines of the claim and of all veins, lodes, ledges, and deposits below such surface and of all the metals, minerals, or precious stones covered by the license, within the vertical planes in which the surface boundaries lie. All gold, precious stones, valuable minerals, or metals obtained after location of a claim but before the issuance of the license are subject to the same regulations as if they had been obtained after issuance of the license.

Different persons in the same area may be granted licenses for different purposes; however, holders of licenses for mining precious stones may not operate in an area where it is held under a concession to mine, dredge, or wash for gold.

## Reward Claim

A reward claim may be granted to the holder of a prospecting license who locates, in accordance with the mining regulations, one or more claims (but no more than six to one person in one locality), not less than 10 miles from an existing working claim, and proves to the satisfaction of the Commissioner, warden, or mines officer that the claim contains gold, silver, or precious stones in commercial quantities.

For a period prescribed by the Governor-General the holder of a reward claim is exempted from payment of the fees specified in the regulations; however, the holder is not exempt from the payment of royalty.

A reward claim remains in existence as long as it is worked to the satisfaction of the Commissioner, warden, or mines officer. Such a claim may be sublet or transferred, but when transferred it ceases to be known as a "reward claim" and the holder is liable to annual license fees.

## Exclusive Permission to Explore

The Governor-General may issue an exclusive permission to anyone to occupy temporarily any unoccupied Crown land for the purpose of testing its value but not for exploitation. However, during the continuance of an exclusive permission to explore, the holder may mark off areas he desires to exploit under a concession or a lease, or he may locate claims within the area.

The terms and conditions of the exclusive permission are set forth in the regulations, but the terms may be varied in any particular case at the discretion of the Governor-General on the advice of the Commissioner.

The permission is limited to an initial period of 3 years with renewals on a year-to-year basis.

The area of the permission must be at least 500 acres and must be defined by natural features or as prescribed by the regulations with respect to the marking of boundaries. All mining claims previously located within the area are excluded from the permit. The holder of the exclusive permit may from time to time abandon any part or parts of the area.

Rent of 7-1/2 cents per acre is assessed during the first 3 years, and is increased with each renewal period until it reaches 20 cents per acre.

## Mining Concessions, Leases, and Licenses

Applications for concessions or leases must be addressed to the Commissioner, for transmission to the Governor-General. The Governor-General, on the terms and conditions he considers equitable, may grant a mining concession or lease; and the Commissioner, with the approval of the Governor-General, may issue a mining license, authorizing anyone named therein to occupy any portion of unoccupied Crown lands and to mine and appropriate minerals.

No concession, lease, or license may be granted for an area in excess of 1,000 acres without the express approval of the Governor-General. When more than one application is received for a concession or lease within the same area, the Governor-General may direct determination by public auction or restrict the competition to any two or more of the applicants.

Licenses to trade in gold and precious stones must be obtained from the Commissioner on payment of fees specified in the Regulations. A license to trade in gold is G$300.00 in Georgetown (the capital) and in precious stones G$700.00. In the interior the fees are G$100.00 for gold and G$200.00 for precious stones.

Concessions are normally granted for 21 years with a right of renewal for a similar period. Upon revocation or termination of a mineral right or lease by the Governor-General, the aggrieved party may obtain a hearing, usually before the Governor's Council. Disputes which arise in the course of operations must be submitted to arbitration when no agreement can be reached with the Commissioner or warden (Arbitration Ordinance). The terms of most mineral grants recognize only the defense of force majeure in actions against the grantee.

## Fiscal Provisions

Filing fees are fixed at G$10.00 for each application for a concession or lease. Concession rentals range from 10 cents per acre for dredging concessions to 40 cents per acre for mining concessions or leases involving gold, silver, valuable minerals, and precious stones.

Royalties are fixed by the Mining Regulations at 50 cents for each ounce of gold and 4 cents for each ounce of silver. The royalty on precious stones is G$1.00 per carat. The Governor-General may fix other amounts that may be specified in any lease or concession.

## Bauxite Mining Regulations

The granting of exclusive prospecting permission and mining leases is at the complete discretion of the Governor; the regulations provide that petitions be submitted directly to the Commissioner. When granted, permits are valid for 1 year but may be renewed for 2 or more years, provided that the exploration undertaken satisfies the Governor.

If the holder of a permission has complied with the provisions of the regulations and if the Governor-General is satisfied that the exploration work carried out has led to the discovery of bauxite deposits, the holder has a right to obtain a lease to mine. The area, duration, and terms of mining leases are determined by the Governor-General.

Financial reports must be sent to the Commissioner, and exports of bauxite are closely checked by the Comptroller while the mining lease is in force.

In the case of bauxite declared to have come from private property, the Comptroller may require a certificate from the Commissioner to the effect that the bauxite in question was mined on privately owned property granted before the passing of the mining ordinance of 1903, and that it is not subject to the payment of royalty. In all other cases, the royalties are applied to the tonnage produced whether exported or not.

## Petroleum

The Governor-General is empowered to grant prospecting licenses, exploration licenses, and petroleum leases. To acquire petroleum rights a corporation must furnish the names and nationality of its directors, the names and holdings of its principal shareholders, and the address of its principal place of business.

### Prospecting Licenses

Prospecting licenses may be issued for areas of less than 200 square miles. Licenses are valid for an initial term of 5 years and may be renewed for two additional terms of 5 years each. The holder of a prospecting license must carry out test drilling and other extensive search for oil to the Commissioner's satisfaction, or forfeit his license.

## Exploration Licenses

Exploration licenses may be granted over areas of not less than 8 square miles; licenses are valid for an initial period of 2 years and are renewable for an additional year. Exploration, topographical studies, geological or geophysical surveys, and borings fulfill the "due diligence" requirement for an exploration license.

Licensees are required to pay specified royalties, in addition to annual rentals.

## Exploitation

Petroleum leases are issued for 30 years, but all leases contain a clause permitting renewal for up to 30 years. Lease terms are set by the Governor-General; however, these agreements have become standardized. At the discretion of the Governor-General individual leases may be consolidated to allow unit development.

Applications for licenses or leases must be made in writing to the Commissioner of Land and Mines for submission to the Governor-General. Data on the location (including boundaries) of the area and evidence of financial and technical qualifications of the applicant must be submitted.

## Fiscal Provisions

As provided in the regulations, annual rentals for petroleum leases range from 50 cents per acre for the first year up to G$3.00 per acre for the 11th and successive years. Rentals may be deducted from royalties during any year if the amount paid as royalties exceeds the amount paid as rent.

Royalties are 12.5 percent ad valorem on crude oil produced and on natural gasoline. On natural gas the royalty is 8 percent ad valorem, subject to a reduction of one-half if the gas is sold to other licensees or lessees for repressuring.

# PARAGUAY

## Controlling Statutes

Mining in Paraguay is governed by Mining Law No. 93 of August 24, 1914, as amended by Law No. 698 of November 5, 1924.[1]

The basic law governing petroleum and other hydrocarbons is Law No. 675 of September 9, 1960, as amended by Decree Law No. 397 of March 31, 1965.

The Mineral Production Administration (Direccion de Produccion Minera), operating through a Department of Geology, handles all matters concerning mining permits and concessions.[2]

## Mining

Minerals are real property separate from surface ownership. Calcareous minerals, rock and earth, and in general all other construction or ornamental materials belong to the surface owner. All other minerals belong to the state and may not be explored or exploited without an authorization or concession from the Government.

All persons, individual or juridical, who have the legal capacity to acquire real property, may acquire and possess mines. The law makes no distinction between nationals and foreigners or between companies organized within the country or elsewhere.

### Exploration Permit

Exploration may be undertaken on any lands after a permit from the Government is obtained. The area granted by a permit may not exceed 500 hectares for each applicant, although one person may be granted four adjoining claims of 500 hectares each. Mining enterprises having available technical personnel may be granted more than four claims. The time of a permit is 8 months, and cannot be extended except in the event of force majeure. A landowner may undertake exploratory work on his own property without a permit, but he has no protection against third persons acting under a permit or concession.

### Exploitation Concession

Mining exploitation concessions may be granted by the Government in pertenencia (claim) units. A pertenencia is a plot of land in a square whose sides are 2 kilometers distant from the center of the concession. A person may apply for one to four pertenencias, regardless of whether they relate to the same vein or mineral deposit. To qualify for a concession the applicant must have either made a new discovery or denounced a forfeited mining concession.

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[1] See also Decree No. 5085 of September 4, 1944 (Registry of Mines), and Decree No. 10,1213 of January 25, 1955 (regulations under Law No. 698).

[2] For information, write to Director, Direccion de Produccion Minera, Ministerio de Obras Publicos y Communicaciones, Asuncion, Paraguay.

In the case of a concession for a new discovery, the applicant must accompany his application with notice of his finding, ore samples, and the statements of two qualified witnesses. Notice is sent to the landowner and published for 60 days to enable any interested parties to object. Upon approval of the Government, the concession is granted by decree and title recorded in the Registry of Mines.

A "denouncement of a mine" occurs when an application is made for the concession of a known mine which was forfeited according to the law. The procedure to be followed is the same as in the case of a new discovery, except that the application must also indicate the name and address of the last concession holder and indicate the reasons for abandonment or other reasons permitting denouncement.

Some of the obligations of concessionaires are (1) to begin exploitation within 5 months by opening a shaft or tunnel 10 meters in length, (2) to undertake marking boundaries of the claim within 5 months for registration of the title in the Registry of Mines, and (3) to operate the mine in accordanc with the technical mining rules as well as police and safety regulations.

The concession grants the right to exploit all minerals found within its boundaries and to make such use of the surface as is necessary to conduct operations. Compensation must be paid to surface owners for use of or damage to their property.

A mining concession may be forfeited by abandonment or by nonoperation (despueble). Abandonment may be expressed or implied when a mine has not been worked for a period of 5 years from the date of concession, it being understood that "work" consists of work performed by not less than five workers for each pertenencia. Furthermore, the failure to open a well or shaft within 5 months or to initiate steps to survey and stake out claims within this period are also regarded as nonoperation of the mine.

## Fiscal Provisions

Article 2 of Law No. 698, amending Law No. 93, provides that the concessionaire is obligated to pay the Treasury a single tax or royalty amounting to 5 percent of the gross proceeds from the minerals exploited. Decree No. 10,123 provides that the Department of Geology shall control the exploitation of a mine and determine the quantity of the extracted substances that belong to the State. The value of this in money is to be based on the price of the mineral in world markets, consideration being given to the probable costs of transportation and other charges. Ores sold or processed within the country will be assessed at current market prices.

## Petroleum

All hydrocarbon deposits are the property of the state. The state has the right to explore, produce, refine, store, and transport hydrocarbons, or it may grant such rights to private concerns through concessions. Persons or companies, either Paraguayan or foreign, who are technically and financially competent, may acquire concessions. Foreign companies must establish a domicile in Paraguay.

## Reconnaissance Permit

A renewable 1-year permit may be granted which authorizes the holder to carry out superficial reconnaissance for oil, including geological and geophysical surveys but excluding drilling. Priority rights for selection of an exploration area within the permit area may be obtained by the permittee by paying US$0.03 per hectare.

## Exploration Concessions

An exploration concession confers exclusive rights to explore an area for a 4-year initial term, which may be renewed twice for 2-year periods. The maximum area of a concession is 1.2 million hectares, comprised of 40,000-hectare lots.

Surface taxes (patents) are US$0.03 per hectare; the rate doubles if the concession is renewed.

## Exploitation Concessions

Upon making a discovery the holder of an exploration concession may obtain an exploitation concession for not more than 50 percent of his concession area. Exploitation concessions, granted for a term of up to 40 years, have a minimum area of 2,000 hectares and a maximum area of 5,000 hectares.

As a guaranty of fulfillment of its obligations, the party requesting the concession must deposit in a bank account designated by the Ministry of Public Works, US$0.10 per hectare, or an acceptable bond for an equivalent amount. This guaranty is refundable and is held only as long as the concession is active.

Minimum drilling requirements are 5,000 meters for every 100,000 hectares during the first 7 years of the concession.

The amount to be invested in exploitation activities shall not be less than US$0.25 per hectare per year, or a minimum of US$200,000 per year. An initial tax of US$0.30 per hectare is payable when production commences.

## Fiscal Provisions

Royalties payable to the Government range from 10 to 15 percent depending upon daily production. Royalties for natural gas and asphalt are 12 and 15 percent, respectively.

Concessions are subject to a progressively increasing surface tax, ranging from US$0.10 per hectare in the first 5 years, to US$1.00 per hectare in the 16th through the 20th year. Thereafter the surface tax progressively diminishes.

A depletion allowance of 27 percent of the gross value of production is allowed, subject to a maximum of 50 percent of the net profits. Dry wells and exploration costs are deductible operating expenses.

Machinery and equipment may be imported free of customs duties.

# PERU

## Controlling Statutes

The Mining Code is Decree Law No. 11,357 of May 12, 1950. Regulations were issued by the Ministerio de Fomento y Obras Publicas on September 4, 1950. Law No. 12,004 of November 19, 1953, controls operations associated with fissionable materials. The Mining Code is applicable to all minerals except petroleum and other hydrocarbons, radioactive substances, deposits of guano and common salt, mineromedicinal waters, pearls, corals, sponges, and ambergris and similar substances.

Law 16,892 of February 24, 1968, amended article 56 of the Mining Code.[1]

Foreign individuals and companies may acquire mining rights, but aliens may not own mines within 50 kilometers of the frontier without special permission of the Government.

The basic laws governing petroleum are the Constitution of 1933, Law 11,780 of March 12, 1952, and Law 12,376 of July 8, 1955. The 1933 Constitution and 1952 law declare ownership of subsoil rights to be vested in the state and characterize as a public utility all exploration, production, refining, transportation, and storage of oil, natural gas, and asphalt. This permits companies engaged in these activities to avail themselves of the state's right of eminent domain.

Article 37 of the Constitution declares that mines and other natural resources belong to the state, except for rights granted by the state. The surface rights to land are separate from the estate in the minerals underground.

## Administration

Under the Organic Law of the Ministry of Energy and Mines, Decree Law No. 17527, March 25, 1969, the newly created Ministry of Energy and Mines was given responsibility for direction and development of all activities relating to energy and mining resources in Peru. Included among the Minister's functions are those of overall policy making, formulating and carrying out specific projects, encouraging research and development, and granting concessions and entering into contracts.[2]

The Ministry contains several subsidiary groups of consultative, assistance, counsel, and executive organizations. The Bureau of Mines and the

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[1] Regulations for implementing Law 16,892 were issued in Supreme Decree 44 of May 10, 1968. Article 56 authorizes the Executive Power to enter into negotiated contracts in order to promote Peruvian mining production and provides for tax incentives and for certain guarantees to foreign investment. An English translation of Law 16,892 and the regulations governing article 56 may be found in the U.S. Bureau of Mines "Mineral Trade Notes," June 1968 and September 1968.

[2] For information, contact Bureau of Mines or Bureau of Hydrocarbons, Ministry of Energy and Mines, Lima, Peru.

Bureau of Hydrocarbons, both executive organizations, are in charge of directing, coordinating, and controlling mining and petroleum activities, respectively. The Registry of Mining Rights and Concessions records all rights and concessions granted by the state, as well as related acts, contracts, and judicial resolutions.

The Empresa Petrolera Fiscal is in charge of hydrocarbon exploration and exploitation in areas assigned to it by the state and has general responsibility for industrialization and commercialization of petroleum and its derivatives.

Until the time of demarcation of a mining concession, disputes are decided by the Regional Mining Supervisors, and appeals are decided by the Director of Mines. Only after the definitive title to a concession has been authorized and registered may it be disputed before the judiciary.

## Mining

There are two types of mining concessions available in Peru: exploration concessions and exploitation concessions.

### Exploration Concessions

On uncultivated, unfenced land, investigation for minerals may be carried out freely, regardless of who owns the land; on other lands a request for an exploration concession may be acquired. A request for an exploration concession is made first to the Regional Mining Headquarters (Jefatura Regional). After review of the application the Director of Mines grants the concession if it conforms with the Code. Priority is given according to time of application. Exploration concessions are valid for 5 years. The area of a concession may range from 1 to 1,000 hectares. There is no limit in the Code on the number of exploration concessions that may be held by one person.

### Exploitation Concessions

Exploitation concessions may be obtained in the same manner as those for exploration. It is not necessary that an exploitation concession be preceded by one for exploration. The duration of an exploitation concession is not stated, and there is no limit on the number of such concessions which may be held by one person.

The holder of a metallic mineral concession acquires rights over all mineral substances covered by the Code, whether they be metallic or not, which may be found within the area of his concession. The holder of a concession for carbonic substances has rights to coal and all other nonmetallic substances within his concession area. The holder of a concession for nonmetallic substances has rights to all nonmetallic substances within his concession area.

The Code requires the concessionaire to permit site inspections by the office of the Director of Mines and to submit written reports, plans, and production data to the Director of Mines. There are Code provisions

regulating wages, employee health insurance, and minimum employment of nationals. Fines may be levied for infractions of the Code. If taxes on land or income are not paid for 3 consecutive years, the concession terminates. Concessions may be relinquished upon request of the concessionaire, provided all obligations to third parties are discharged.

The state is authorized to set aside certain mineral reserves, which the National Government may operate directly or may lease to private individuals or corporations.

To promote the early development of unworked mining concessions the Government by Decree No. 17792 of September 2, 1969, demanded the immediate commencement of activities on inactive concessions which were granted prior to June 19, 1965. A concessionaire must thus commence mining activity within 5 years after the granting of the concession, or the Government may revoke his right.

## Fiscal Provisions[3]

An annual fee tax of 1.50 soles (1 sol = US$0.037) per hectare is levied in advance on an exploration concession and is payable for the first year at time of application. Concessionaires for mines, dumpings, tailings, and slags are subject to an annual land tax per hectare as follows: 4.50 soles for gold and coal concessions, 20 soles for nonmetallic concessions, and 55 soles for metallic concessions. An annual tax of 2 soles for each metric ton of installed daily capacity is levied on refining plants. A quadruple tax is levied against any concessionaire who does not produce minimum quantities of minerals after 5 years' possession of the concession. Minimum production standards vary with each type of mineral concession and are determined by the appropriate authority.

Decree Law 17,791 of September 2, 1969, gives new tax benefits to mining concessionaires. These benefits include 100-percent depreciation of investments in machinery, equipment, and installations made each fiscal year, up to the sum of 10 million soles; a 20-percent authorization rate during a 5-year period for those items up to 30 million soles; and tax exemption of any net profits used in capitalization within 6 months subsequent to the closing date of the concessionaire's balance sheet. These provisions, however, do not apply to production units subject to contracts under article 56 of the Mining Code.

Small producers pay lower fees under a similar tax scheme and under Decree Law 17,791 they are given certain other benefits. A small producer is defined as a concession holder possessing up to 1,000 hectares and producing less than 500,000 soles monthly.

Article 56 of the Mining Code, as amended, authorizes the Executive Power to make contracts prior to 1978 with both national and foreign private companies and individuals. The article authorizes the reduction of the income

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[3] Law 16,006 amended Laws 11,357 and 15,584 which were amendments to the Mining Code tax provisions.

tax and supplementary tax for specified periods, usually 10 years after the date operations commence. Rapid depreciation schedules, revaluation of assets, carryover of losses, and exemption from custom duties are also authorized. Permanent depletion allowance benefits are not provided. Matters concerning housing, hospital benefits, education, safety, and other workers' rights are left to negotiations.

### Fissionable Materials

The Atomic Energy Control Board has administrative control of radioactive substances under Supreme Decree No. 1 of November 16, 1955, and Supreme Decree of December 28, 1955. Individuals and corporations, foreign and national, may be granted exploration concessions for 2 years and exploitation concessions for an indefinite period. During the exploration period the extraction of radioactive substances is prohibited, except where necessary to prove a deposit. The exploration, exploitation, treatment, transportation, sale, and exportation of radioactive substances are subject to the regulations and controls of the Board. The Board furnishes facilities, technical advice, and other services without cost, and will provide instruments for use in prospecting at cost price.

## Petroleum

Under the 1952 petroleum law, the state may engage in oil production or may grant concessions to private individuals and companies. Foreign companies may acquire concessions for areas which are not within 50 kilometers of a border. Foreign governments and state-owned companies are not eligible to acquire concessions.

Foreign concessionaires must renounce rights to diplomatic intervention, establish a domicile in Lima, and appoint a Peruvian representative. In the case of foreign-owned companies organized in Peru, 30 percent of the shares must be offered for sale to Peruvians for not less than 90 days.

The country is divided into four zones: (1) the Coast zone, from the Pacific Ocean to the 2,000-meter elevation mark on the west side of the Andes, (2) the Sierra zone, from the 2,000-meter mark on the west side of the Andes to the same elevation on the east side, (3) the Oriente zone, from the Sierra zone to the eastern boundary of Peru, and (4) the Continental Shelf zone, extending 200 miles seaward from the Coast zone. Concession terms vary in each zone and are least rigorous in the jungle areas.

### Reconnaissance Permits

This right authorizes prospecting for an indefinite period over the area stipulated in the permit. The right is nonexclusive, gives no priority to the holder, and may be canceled at any time by the executive power. The holder may carry on permitted investigative activities not within the scope of exploration concessions.

## Exploration

The duration of exploration concessions is 3 years in the Coast zone, 5 in the Sierra, and 6 in the Oriente. Two renewals for 1- or 2-year periods are allowed. The maximum area per concession is 20,000 hectares in the Coastal and Sierra zones, and 50,000 in the Oriente. Generally, no more than 20 concessions may be held by one concessionaire, but additional areas may be obtained through auctions. During the exploration stage a minimum investment must be made, amounting to 15 soles per hectare in the Coastal and Sierra zones and 2.50 soles per hectare in the Oriente. Applicants for concessions must deposit a cash guarantee when they file their bids, and this sum is returned at the expiration of the concession. A progressively increasing surface tax is payable annually.

Concessions in the Continental Shelf zone, which has been set aside as a national reserve, may be obtained in the following order of priority: (1) the State, (2) the State in association with national capital, (3) national natural or juridical persons, and (4) by auction in which foreign companies may participate.

## Exploitation

An exploitation concession may be acquired directly or through conversion of an exploration concession. Applicants must pay an exploitation bonus, which is based on acreage, and make a cash deposit as a guarantee of performance. The duration of exploitation concessions is 40 years in the Coastal zone, 45 in the Sierra, and 50 in the Oriente. Renewals for 20 or 25 years are permitted. The maximum area of a concession is 10,000 hectares in the Coastal and Sierra zones, and 25,000 hectares in the Oriente. In addition to areas obtained through auctions or conversion of exploration concessions, a single concessionaire may not hold more than 10 concessions in any one zone.

Concessionaires are under an obligation to supply a portion of domestic demand at prices fixed by the Government under a formula based on world market prices and transportation and refining costs. Concessions may be terminated for failure to pay taxes or to carry out basic obligations.

Exploitation concessions are subject to progressively increasing surface taxes, with some reductions allowed if a stated level of production is maintained. After 20 years the tax rate is progressively reduced.

A basic export tax, amounting to 20 percent of the f.o.b. value of crude oil or refined products plus a special ad valorem tax, for oil produced in the Coastal zone is assessed and considered to be an advance payment of the special income tax. The export tax rate is less for oil produced in the Sierra and Oriente zones (3 percent during the first 10 years, 5 percent during the next 10 years, 7 percent during the next 10 years, and 10 percent thereafter).

Concessionaires are liable for a special income tax, which amounts to 50 percent of net profits in the Coastal zone and lesser amounts in the Sierra and Oriente (10 percent during the first 10 years, 25 percent during the next 10 years, 35 percent during the next 10 years, and 50 percent thereafter).

In calculating net profits for the purposes of this tax, a depletion allowance and the basic export tax may be deducted. In the Coastal zone, the depletion allowance is 15 percent of gross production, but may not exceed 50 percent of net profits after deduction of the depletion allowance and export tax. In the case of national companies (in which Peruvians own at least 60 percent of the stock and comprise two-thirds of the directors), the allowance is 25 percent and the limitation is 50 percent of net profits before deduction of the depletion allowance and export tax. In the Sierra and Oriente, the allowance is 27.5 percent, subject to the same limitation as national companies.

## Concessions for Pipelines, Refineries, and Storage Facilities

Concessions for pipelines, refineries, and storage facilities may be obtained for a period of 40 years and may be extended another 40 years. The Government may require that surplus capacity be made available to third parties, at rates fixed by the Government if the parties cannot agree. Upon expiration of a concession, the Government has the right to acquire the property for fair compensation; otherwise, the concessionaire may remove the equipment and may be granted exemption from export duties.

During the initial term of a concession, payment of the taxes specified in the petroleum law exempts a concessionaire from liability for all other national, regional, and local taxes. Upon renewal of a concession, the contributions, taxes, and other obligations in force at that time become applicable.

Materials which are imported for use by a petroleum concessionaire are exempt from import duties if they are exported within 2 years after entry. Drilling and other equipment used in exploration and production in the Sierra and Oriente zones is subject to 50 percent of the duties in effect at the time of importation. Material used in the Coastal zone is subject to full duties.

# SURINAM

The Mining Code of March 20, 1953, governs the development of all minerals including petroleum, with the exception of certain construction materials.[1] Ownership of Surinam's minerals is reserved to the Provincial Government. Mineral rights may be issued only to residents of the Netherlands, Surinam, or the Dutch West Indies, or companies domiciled in those countries. The Mining Code authorizes the granting of the following mineral rights, the terms of which are determined within limits set forth in the Code by the Governor upon consultation with an Advisory Council.

## Investigation License

This license gives permission to conduct surface prospecting for a period of 1 year. It does not include a priority right to a license or concession.

## Exploration License

This license grants the right to prospect for minerals and to be granted a concession to exploit minerals specified in the license in all or part of the licensed area. A licensed area may not exceed 20,000 hectares. The term of a license may not be more than 3 years. Renewals for two 1-year periods are discretionary.

## Operating Concessions

A concession will be issued for commercial deposits for a term of 1 to 40 years. The area of a concession may not exceed 2,000 hectares. The concessionaire is required to begin production within 3 years and to proceed diligently.

Prospecting and extraction licenses are issued only to individuals for small-scale operations which are conducted by simple means.

Bauxite is mined under special concession agreements with the Government. Granting of future concessions is reported to be conditioned upon a portion of the ore being processed in Surinam, and firm undertakings by the concessionaire regarding the purchase of hydroelectric power.

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[1] For information, write Surinam Government Geological and Mining Service, Kleine Waterstraat, Paramaribo, Surinam.

# URUGUAY

## Controlling Statutes

The development of all mineral resources is governed by the Mining Code, Decree Law 10,327 of January 28, 1943. The Code is administered by the Inspector General of Mines.[1]

Development of petroleum resources is also subject to Law 8764 of October 15, 1931, Law 9824 of May 17, 1939, and Law 9835 of June 15, 1939. These laws convey all rights of exploration, production, and refining to the Administracion Nacional de Combustibles, Alcohol, y Portland (ANCAP).

## Mining

All minerals are the property of the state, except specified building, industrial, and ornamentation materials. Any citizen or company domiciled in Uruguay may obtain permission to carry out exploration and production activities.

### Exploration License

A license may be obtained from the Inspector General of Mines granting exclusive rights to explore for minerals within a specified area, not exceeding 2,000 hectares. The duration of a license is 10 months, subject to renewal for 5 months. A discovery gives the holder a right to a provisional mining concession.

### Mining Concessions

There are two classes of mining concessions. A provisional concession is granted for 1 year to permit development work necessary to outline the ore body and determine its commercial value. This concession may be renewed for 2 years. The area of a concession may not exceed 20 hectares and must be included in the area of exploration or denouncement. Proof must be submitted concerning the existence of the deposit and the financial capacity of the applicant. The plan of operation is subject to approval by the Inspector General.

A permanent concession is issued if the deposit can be commercially exploited. A concession may include 30 hectares and have a duration of not more than 75 years.

A concession may be terminated for (1) suspension of operations without cause for more than 90 consecutive days or for more than 150 days during a 2-year period, (2) failure to obey the law, (3) failure to pay taxes, (4) abandonment, or (5) technical or financial inability to continue operations.

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[1] For information, write Inspeccion General de Minas, Ministerio de Industria y Comercio, Montevideo, Uruguay.

Extensive safety and inspection regulations are prescribed by Decree of September 30, 1946, as amended.

## Financial Provisions

Concessions are subject to a surface tax of 200 pesos (1 peso = US$0.135) per hectare per year. Royalties range from 3 to 6 percent of value of production, and are fixed in the concession agreement. If the concession holder discovered the deposit, he is exempt from royalties for 5 years. An export tax of 0.5 percent is paid on untreated ores. Concessionaires are liable for all taxes of general application.

## Petroleum

Petroleum has not yet been discovered in the country. Were it to be found, the discoverer would receive, in accordance with the provisions of the Mining Code, compensation from the proceeds of the production for the first 5 years of operations. ANCAP, as mentioned above, holds all rights of exploration, exploitation, and refining.

# VENEZUELA

## Controlling Statutes

The law governing the development of minerals other than hydrocarbons is the Mining Law of December 28, 1944, and regulations of the same date. In 1967, the Ministry of Mines and Hydrocarbons formed the Mining Legislation Committee to consider new mining legislation.

The Law of Hydrocarbons of 1943, as amended in 1955, is the basic law governing development of petroleum resources, but no new concessions have been granted to private parties since 1958. Private firms may obtain service contracts with Corporacion Venezolana Petroles (C.V.P.) under the Law of Hydrocarbons of August 7, 1967. Venezuela is a member of the Organization of Petroleum Exporting Countries (OPEC).

## Mining

In theory, the States of the Venezuelan Union are the owners of mineral deposits within their boundaries. However, under article 60(17) of the national Constitution, the States are prohibited from enacting legislation in this field. All mineral resource development is subject to regulation by the Ministry of Mines and Hydrocarbons.[1] The Mining Promotion Committee has recently been established to interest private investors in developing medium-size mining operations.

Generally, any person or company, national or foreign, may acquire concessions. Exceptions include certain public officials and all foreign governments. Foreign companies must fulfill requirements under the Commercial Code. Concessionaires not domiciled in Venezuela must appoint a representative within the country.

Mineral rights are separate from surface rights.

### Administration

Within the Ministry are two Departments: the Department of Mines, which is responsible for the general administration of the law, and the Department of Administration, which is responsible for fiscal matters. Three services assist the Ministry: the Technical Service of Mining and Geology, the General Technical Inspectorship, and Fiscal Inspectorships. All mining titles must be registered in the local registry office, and applications, notices of discovery, denouncement, and title, and resolutions must be published in the Official Gazette. Controversies which may arise in connection with concessions are settled by a competent court of Venezuela.

### Reserve Areas

The Federal Executive, by means of a decree, may exclude from the normal procedure of filing claims any or all mineral substances found within the

[1] For information, write Consultor, Juridico, Ministerio de Minas e Hidrocarburos, Caracas, Venezuela.

country in specified zones. Concessions in these reserve zones are granted by the Federal Executive, at its discretion. Three classes of concessions are available in reserved zones:

Class 1: for the exploration of plots, whose area may not exceed 5,000 hectares, and in which the concessionaire has the right to exploit parcels which he may later select, not exceeding 50 percent of the original area. The duration of the exclusive exploration stage is 2 years, at which time plots for exploitation must have been selected.

Class 2: for the exploitation of plots not exceeding 500 hectares in area. Applications are submitted in the same manner as for class 1 concessions. A plan of operations must be approved before the concession is granted.

Class 3: for the exploitation of national reserves remaining following the relinquishment of areas under class 1 concessions. These concessions are granted after the Ministry announces the reserve open to proposals and following receipt and evaluation of bids.

## Exploration Permits

No permit is required in order to carry out exploration on unleased public lands; however, notice must be given to the Ministry and chief civil authority of the municipality.

An exlusive exploration permit may be obtained from the Ministry covering areas not larger than 2,000 hectares. Not more than five exploration permits may be granted to a single applicant. An annual surface tax must be paid. The duration of a permit is not more than 2 years, during which the holder may file claims within the permit area.

## Claim Concessions

A mining concession may be acquired by entering a claim, containing a description of the applicant and the claim, in the registry office of the local jurisdiction. The claim is forwarded to the Ministry, which will require the claimant to present a plan of the concession within 12 months. The area of a concession for veins or strata may not exceed 500 hectares; for alluvial deposits, the maximum area is 1,000 hectares. No person may hold a total of more than 10,000 hectares for veins or strata, or more than 20,000 hectares for alluvial deposits. The duration of a concession for veins or strata is 50 years; for alluvial deposits, 25 years. One renewal for a period equal to the original term is permitted upon payment of a special tax equal to 4 times the yearly average of mining taxes already paid.

A concession must be in operation within 5 years for veins or strata, and within 3 years for alluvial deposits. Once operations have begun, they may not be suspended for more than 2 consecutive years in the case of veins or strata, or 1 year for alluvial deposits.

No special permit is required for the exploitation of alluvial minerals of any class in public lands or riverbeds not subject to a concession, provided exploitation is carried out by primitive processes.

Concessionaires must carry out operations in accordance with accepted industry practices and avoid waste and damage. Specified books must be kept and reports made periodically to the Ministry. Transfers of concessions are authorized after notification to the Ministry. Concessionaires have rights of expropriation to obtain the use of land necessary to their operations, when no agreement can be reached with the surface owner.

Claim concessions may be declared expired for the following reasons: failure to pay taxes, failure to commence operations, suspension of operations, and expiration of the term of the concession.

### Fiscal Provisions

In the case of concessions in the reserve zones, financial terms are the subject of negotiations with the Federal Executive.

In the case of claim concessions, a surface tax of 1 bolivar (1 bolivar = US$0.223) per hectare is paid for veins or strata, and 0.50 bolivar per hectare for alluvial deposits. Exploitation taxes are 1 percent of market value of refined metal in Caracas for gold, silver, platinum, and associated metals, 3 percent of market value in Caracas for diamonds and other precious stones, and 1 percent of value at mine for other minerals.

Materials which are necessary for the development and operations of mines and treatment plants may be imported free of duty.

## Petroleum

The 1943 law authorized the granting of four types of concessions: (1) Exploration-exploitation, (2) exploitation, (3) manufacturing-refining, and (4) transportation. The rights conveyed by the latter two are included in the first two types of concessions. Concessions could be granted to any person or company, Venezuelan or foreign, foreign governments and certain Venezuelan officials.

The Law of August 1967 Amending the Hydrocarbons Law to Provide for Service Contracts contains some fundamental amendments to the 1943 law. The right to explore, exploit, manufacture, refine, and transport hydrocarbons may be exercised only by the Federal Executive, or by corporations owned exclusively by the state. These organizations may enter into agreements and promote mixed ventures to exercise these rights, provided that the terms and conditions in each contract are more favorable to the state than those set forth for concessions in the present law.

Service contracts are subject to the approval of the Congress. The duration of contracts may be up to 20 years from the start of exploitation. The period of exploration may not exceed 5 years. In special cases, and after

prior authorization of the Congress, the duration may be up to 30 years, including the exploration period.

Maximum area, shape, orientation, and other specifications are to be set forth in bases for contracting which may be approved by the Congress. The contracting parties must agree to relinquishments, by a process of alternate selection, so that the area for exploitation does not exceed 20 percent of the original area. Disputes of any nature shall be decided by the competent courts of Venezuela.

## Fiscal Provisions

The petroleum industry is subject to surface, production, consumption, and transportation taxes, in addition to ordinary income taxes and a surtax.

The annual exploration surface tax is 2 bolivars per hectare. The annual exploitation surface tax is 5 bolivars per hectare for the first 10 years, increasing 5 bolivars every 5 years until the tax reaches 30 bolivars per hectare. The exploitation concession holder is required to pay an initial exploitation tax of 8 bolivars per hectare, when the production area is delimited, and a minimum fixed production tax of 16-2/3 percent annually on oil and gas production. Prices for the purpose of calculating the production tax are fixed by the state and are related to the posted prices in the United States for Gulf of Mexico production. The production tax may be lowered or temporarily waived if the producer proves that the increasing cost of production has reached the limit for commercial operations.

For income tax purposes the cost of finding petroleum is capitalized and recovered by cost depletion allowances. In addition to paying income taxes at ordinary rates, petroleum companies are subject to an additional tax to give the state revenues equal to at least 50 percent of the company's net income.

The Executive has discretion to exempt equipment and materials from import duties. This is done through contracts with each company.

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# FLY ASH UTILIZATION

## A Summary of Applications and Technology

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1970

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By John P. Capp and John D. Spencer

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TABLES

# FLY ASH UTILIZATION

## A Summary of Applications and Technology

by

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ABSTRACT

Information is summarized on the major uses of fly ash and prospects for utilization in agriculture and in brick and mineral-wool manufacture. Technological aspects of utilization are discussed and references are given to the work of many of the leaders in the fields of fly ash production, processing, and utilization.

## INTRODUCTION

Widespread use of the pulverized fuel burner by electric utilities has produced significant amounts of fly ash that have found relatively limited use. In the 2-1/2 decades since the end of World War II, an estimated 300 million tons of fly ash have been produced in the United States, of which only about 3 percent has been utilized. Assuming that projected fly ash production and utilization trends prove accurate, another 300 million tons of fly ash will have accumulated by 1980. It is apparent that continued effort is desirable to develop new fly ash outlets and expand existing ones.

Since fly ash disposal costs range from $0.25 to $2.00 per ton, there is economic incentive to convert fly ash from a liability into an asset. Nevertheless, although the past several years have seen a steady growth in fly ash consumption and increased efforts to develop new uses, utilization has not yet advanced to where the demand even approaches the supply. Approximate total amounts of fly ash and bottom ash produced and utilized in 1967 in the United States, as given in table 1, is typical of recent years.

The purpose of this report is to summarize information on the major uses of fly ash and utilization for agricultural purposes and brick manufacture. Although commercial markets for the latter two have not been developed, exploitation for these purposes appears promising.

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TABLE 1. - Utilization of ash in the United States in 1967[1]

| Markets | Fly ash | | Bottom ash[2] | | Total | |
|---|---|---|---|---|---|---|
| | Tons | Percent | Tons | Percent | Tons | Percent |
| Road and construction fill................ | 300,000 | 20 | 1,150,000 | 50 | 1,450,000 | 38 |
| Concrete additive.... | 600,000 | 39 | 200,000 | 9 | 800,000 | 21 |
| Lightweight aggregate | 150,000 | 10 | - | | 150,000 | 4 |
| Stabilization for road base........... | 120,000 | 7 | 50,000 | 2 | 170,000 | 4 |
| Cement manufacture... | 150,000 | 10 | 50,000 | 2 | 200,000 | 5 |
| Asphalt filler....... | 120,000 | 7 | 35,000 | 1 | 155,000 | 4 |
| Miscellaneous........ | [3]120,000 | 7 | [4]820,000 | 36 | 940,000 | 24 |
| Utilized............. | 1,560,000 | | 2,305,000 | | 3,865,000 | |
| Produced............. | 18,500,000 | | 9,200,000 | | 27,700,000 | |
| Utilization....... | | 8 | | 25 | | 14 |

[1]National Ash Association, Washington, D.C.
[2]Includes boiler slag.
[3]Includes abrasives, foundry sand, oil well cementing, and plastic and chemical products.
[4]Includes blasting grit, ice control, agriculture, and roof filler.

Readers interested in practical applications or desiring additional details on the subjects presented are referred to the section on References at the end of this report. Reference to specific models of equipment is made for identification only and does not imply endorsement by the Bureau of Mines.

## PHYSICAL AND CHEMICAL CHARACTERISTICS OF FLY ASH

Mineral matter occurs in coal as two broad types, inherent and extraneous (59),[3] the latter making up the largest portion. Common minerals identifiable in coals include pyrite, marcasite, chalcopyrite, arsenopyrite, stibnite, gypsum, calcite, quartz, siderite, kaolinite, dolomite, apatite, mica, and many others (14, 37, 64). Alteration, decomposition, and transformation by heat of this mineral matter during the combustion of pulverized coal produces fly ash, a complex and finely divided solid material. Fly ash is comprised of compounds of silicon, aluminum, iron, and calcium, smaller amounts of compounds containing magnesium, titanium, sodium, and potassium, and traces of other elements. These compounds occur in fly ash primarily as silicates, oxides, and sulfates, along with lesser amounts of phosphates and carbonates. Silica content ranges from less than 30 percent to more than 50 percent.

Physically, fly ash consists of finely divided spheroids of siliceous glass ranging from 1 to 50 microns in diameter. Some of the spheroids are considerably finer than portland cement, and a minor fraction consists of larger irregularly shaped particles, some opaque and some transparent or translucent. Carbon is also present chiefly in the form of irregularly shaped particles of coke. Depending upon the type of coal and powerplant conditions, carbon in U.S. fly ashes ranges from less than 1 percent to more than 20 percent.

[3]Underlined numbers in parentheses refer to items in the list of references preceding the appendixes.

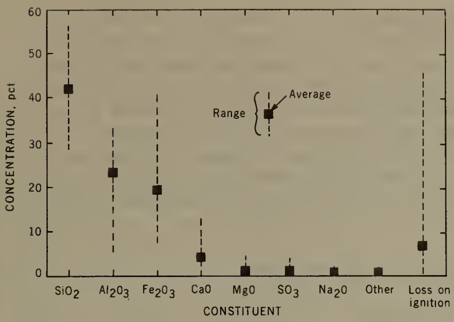


FIGURE 1. - Range and Average of Analyses of United States Fly Ashes.

Studies have revealed the glassy material in fly ash to be extremely stable (47). Almost no cracking, crystallization, or other indication of deterioration has been observed following exposure to weathering in stockpiles for more than 30 years.

The range and average of constituents in U.S. fly ashes are given in figure 1 (23). While fly ashes vary physically and chemically, depending on the coal type and locality, these variations can be determined and means can be taken to make them meet specifications for the intended purposes. Carbon content can be controlled by monitoring the color of the ash and adjusting combustion conditions to effect compensation. When this is not possible, offcolor fly ash can be diverted from the quality material silo. Grinding facilities can also be installed to process fly ash so that it will meet fineness specifications.

## CEMENT AND CONCRETE

Utilization of fly ash in concrete, concrete block manufacture, precast concrete products, and mortar has constituted the largest single market for the material in recent years. The addition of fly ash to concrete improves or imparts certain properties, including strength, resistance to sulfate attack, workability, and permeability, and helps control shrinkage and evolution of heat during setting. Fly ash concrete reportedly clings less tenaciously to forms and retains sharper corners and details that enhance the architectural value of construction shapes.

Fly ash utilization as a raw material in the manufacture of cement is another market, one that has been barely tapped. About 150,000 tons of fly ash, 10 percent of the total used in 1967, went into cement manufacture that year. This market appears to have considerable potential, however, because cement production in the United States is about 380 million barrels per year (94 million tons) and probably will continue to increase.

Fly ash is valuable in cement and concrete manufacture because it is a pozzolan. Pozzolans are siliceous or siliceous-aluminous materials that have little or no cementitious value themselves but, in finely divided form and in the presence of moisture, are able to chemically react with calcium hydroxide and other alkaline earth hydroxides to form compounds that possess this property. For example, approximately 12 to 20 pounds of lime per bag of cement will not combine (because of the lack of siliceous material for reaction) and remains as a soluble material. In time, as this material leaches from the concrete some deterioration and discoloration results. Fly ash reacts with the alkalies released by hydration of portland cement, thereby minimizing the

effects of excessive alkali and the susceptibility to attack by sulfates. Addition of fly ash to alkali-reactive aggregates is especially advantageous. Artificial pozzolans in addition to fly ash include heat-treated clays and shale and blast-furnace slag. Natural pozzolans include some volcanic ashes, diatomaceous earth, and bauxite. Pozzolanic reaction rates are known to depend upon both the mineral composition and fineness of the pozzolan. A substantial percentage of the silica should be the amorphous type because it is more reactive than the crystalline form. Most good pozzolans contain substantial quantities of alumina and iron oxide and at least small amounts of alkalies.

## Advantages of Fly Ash in Concrete

### Workability

Fly ash, like other good pozzolans, improves the workability of a concrete mix by making it more plastic, decreasing particle segregation, and decreasing bleeding (10). This influence of fly ash has been attributed to the spherical shape of the fly ash particle (65). Thus, the use of fly ash may be desirable when the aggregate lacks sufficient fines or the cement has a marked tendency to bleed (69). The ash can be added to the concrete batch at the mixer or can be premixed with the dry cement.

### Water Requirement and Heat of Hydration

For equal slump values, more water is usually required for making concrete when pozzolan has been added to the mix. Fly ash differs from most pozzolans in this respect (10). Some pozzolans greatly increase the "fatness" of concrete: a portland-pozzolan concrete with 1- or 2-in. slump may be placed just as readily as a corresponding portland cement concrete of considerably higher slump. A remolding apparatus is said to provide a more reasonable measure of workability of pozzolan-cement concretes than the slump test (21).

Concretes containing low-carbon fly ash (2 percent) generally require less water than portland cement concrete, and water requirements for concretes with 10 and 20 percent replacement of cement are virtually the same (22). Concretes with fly ashes containing an excess of about 2 percent carbon require proportionately more water than does standard concrete and the water requirement for a 20-percent replacement mix is higher than for a 10-percent replacement mix. Beyond this, there is no consistent relation between carbon content and water requirement. In general, the finer the fly ash, the lower the water requirement.

Portland cement concrete mixes containing fly ash have a lower heat of hydration, consequently do not get as warm as equal amounts of portland cement. Fly ash-concrete mixtures that were used to construct Hungry Horse Dam for example produced less than one-half the heat produced by equal weights of modified portland cement concrete (10).

## Shrinkage and Expansion

Fly ash concretes shrink and crack less upon drying than do standard concretes or concretes containing natural pozzolans (10, 68) although these differences are considered to be minor. Autogenous shrinkage of fly ash concrete is also slightly lower than that for the other types of concrete. (Autogenous shrinkage is shrinkage caused by continued reaction of ingredients after the concrete has hardened.) Moreover, concretes containing relatively high percentages of fly ash reportedly shrink less than those with smaller amounts of fly ash (68). Davis and others report contrary results, stating that fly ashes containing more than 10 percent carbon make a concrete that generally will contract about 5 percent more than will standard concrete (22). Exposure conditions are important factors in the development and effects of the reaction. Portions of structures exposed to adverse weather conditions show early distress, whereas protected portions of the same structure fail to develop appreciable distress, if any.

Research has been conducted on the effect of adding finely divided pozzolans to combine with alkalies while the concrete is still plastic, to reduce the alkali concentration, and to prevent later expansion reactions in the hardened concrete (69). The results indicate that cements containing more than 0.5 percent alkali require about 20 grams of reactive silica per gram of alkali in excess of 0.5 percent. Reliable corrective materials (minus 200 mesh) include fly ash, opal, diatomite, volcanic ashes, calcined shale, Pyrex, and other active siliceous materials. Most fly ashes are more effective than raw shale or slag in reducing expansion caused by alkali-aggregate reaction but are less effective than calcined shale and opal. Some pumicities and other volcanic ashes are less effective than fly ashes in reducing alkali expansion; others are more effective (10, 14, 21).

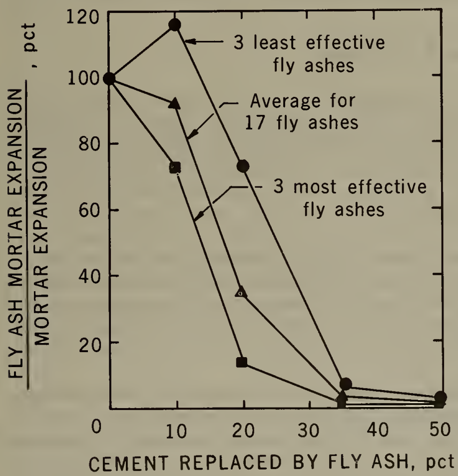


FIGURE 2. - Effect of Fly Ash on Expansion of Alkali-Reactive Mortar at Age of 1 Year.

Figure 2 shows the relative effectiveness of 17 fly ashes in preventing or reducing expansion resulting from the alkali-aggregate reaction. It is evident that any of the fly ashes tested will prevent expansion caused by the alkali-aggregate reaction if enough ash is used. At an age of 1 year, for example, replacement of 35 to 50 percent of the cement by any of the fly ashes limited the change in volume to a maximum of 0.04 percent, which is comparable with that shown by nonreactive mortars (14). Although replacement of 20 percent of the cement by fly ash reduced the

expansion at 1 year, it did not reduce it to a safe amount in all cases, indicating that all fly ashes are not equally effective in this regard. For the mortar used in these tests, a 10-percent replacement of cement with fly ash did not substantially reduce expansion, and in some cases, increased the volume. At an age of 1 year, specimens prepared with seven of the 17 fly ashes in the 10-percent replacement group showed more expansion than did the control specimens.

However, mortar tests may not reflect the actual behavior of these materials when used in concrete, hence such tests should not be substituted for tests of concrete specimens to determine how much fly ash should be used to prevent expansion in a reactive concrete. ASTM has two physical tests for determining potential volume changes of mortars resulting from cement-aggregate combinations (C227, C342) and a chemical test for determining the potential reactivity of aggregates (C298).

## Permeability to Air and Water

Air permeability of both solid and hollow-core concrete blocks containing fly ash has been shown to be at least one-fifth less than for comparable concrete blocks (25). Minimum permeability to air is important in blocks used to direct the flow of air in coal mines (mine stoppings) because less power is required for air circulation.

Concrete with low permeability is also important in dam construction. Concrete has been found to be less permeable when part of the portland cement was replaced with fly ash (10).

## Sulfate Resistance

Some concretes are deteriorated by sulfates of sodium, magnesium, and calcium in alkali soils and waters. Sulfates react chemically with the hydrated lime and hydrated calcium aluminate to form calcium sulfate and calcium sulfoaluminate, accompanied by considerable expansion and disruption of the concrete. Alkali concentrations in soils increase in dry seasons when dilution is at a minimum, and the stronger the concentration, the more rapid the disintegration of the concrete. Continued exposure of concrete to concentrations as low as 0.1 percent, however, may be harmful (69). Deposition of sulfate crystals in the pores of concrete also tends to disintegrate concrete. Growing crystals resulting from alternate wetting and drying of alkali waters may eventually fill the pores and develop pressures sufficient to disrupt the concrete.

Resistance to sulfate attack from sea water, soil solutions, and natural acid waters can be increased by the use of fly ash or other pozzolans. The relative improvement is greater for concrete of low cement content. Pozzolans generally are employed in proportions of 1 part pozzolan to 5 parts of cement to 1 part pozzolan to 2 parts of cement, calculated either by weight or by absolute volume. Pozzolans generally are lighter than portland cement and therefore, if used on a weight basis, produce a greater total absolute volume of cementitious material. Pozzolan additions to sulfate-resisting portland

cements do not increase their sulfate resistance and, if chemically active aluminum compounds are present in the pozzolan, may actually reduce the sulfate resistance of the concrete.

In domestic sewers, concrete is frequently exposed to attack by sulfuric acid through contact of hydrogen sulfide with the wet upper surfaces. Addition of fly ash to concrete mixes made with Type I portland cement can materially increase resistance of the concrete to sulfuric acid attack, as shown in table 2 (72). Concrete containing Type II cement is shown to be quite resistant to such action, with or without fly ash.

TABLE 2. - Resistance of concrete and fly ash concrete to 1 percent $H_2SO_4$[1]

| Portland cement, sacks/ cu yd | Fly ash in mix | | Net water content, gal/cu yd | Net air content, percent | Change in dynamic E during immersion in 1 percent $H_2SO_4$ for period indicated, percent | | | |
|---|---|---|---|---|---|---|---|---|
| | Lb/cu yd | Wt pct | | | 4 months | 8 months | 12 months | 20 months |
| NON-AIR-ENTRAINED CONCRETE | | | | | | | | |
| Type I: | | | | | | | | |
| 5.52... | 0 | 0 | 33.8 | 0.8 | +18 | -3 | -50 | ([2]) |
| 4.45... | 104 | 20 | 32.4 | .6 | +18 | +24 | +17 | +25 |
| Type II: | | | | | | | | |
| 5.55... | 0 | 0 | 33.8 | .6 | +23 | +27 | +25 | +35 |
| 4.43... | 104 | 20 | 32.2 | .5 | +24 | +31 | +24 | +36 |
| AIR-ENTRAINED CONCRETE | | | | | | | | |
| Type I: | | | | | | | | |
| 5.53... | 0 | 0 | 31.7 | 4.0 | +20 | +24 | +8 | ([2]) |
| 4.42... | 104 | 20 | 29.1 | 4.9 | +10 | +24 | +19 | +29 |
| Type II: | | | | | | | | |
| 5.53... | 0 | 0 | 30.0 | 4.7 | +22 | +24 | +21 | +31 |
| 4.44... | 104 | 20 | 27.9 | 4.7 | +23 | +30 | +24 | +34 |

[1]Slump, 3 to 4 in.; each value is the average for three beams.
[2]Disintegrated.

## Strength

Conflicting information appears in the literature regarding the effect of fly ash on the strength of concrete. This may be because mixes in which fly ash is substituted for cement on a 1 for 1 basis (to conform to water-cement ratio specifications) produces concretes that are virtually always weaker than control mix concretes at ages up to 28 days. However, much ready-mixed concrete is required to meet 28-day minimum strength values (36), and properly proportioned fly ash concrete mixes can produce concretes with 28-day strengths comparable to concrete without fly ash. The data in table 3, for example (72), show that equal 28-day strengths can be achieved, although more fly ash must be added than the amount of portland cement removed. Of interest also is the fact that mixes containing 70 to 188 lb/cu yd of fly ash required less water for a given slump than comparable mixes made without fly ash. On the other hand, concrete made with fly ash required more air-entraining agent for a specific air content than concrete made without fly ash, and this

increase may vary considerably with different fly ashes depending on carbon content of the fly ash.

TABLE 3. - Effect of fly ash on compressive strength of concrete

| Portland cement, sacks/cu yd | Fly ash, lb/cu yd[1] | Water added, gal/cu yd | Air-entraining agent, oz/cu yd | Slump, in. | Net air content, percent | Compressive strength of 6- by 12-in. cylinders moist-cured at 72° F, psi[2] 7 days | 28 days |
|---|---|---|---|---|---|---|---|
| 5....... | 0 | 33.8 | 6.1 | 4.50 | 4.6 | 2,230 (100) | 3,540 (100) |
| 4-1/4... | 70 | 33.0 | 6.8 | 5.00 | 4.8 | 1,930 ( 87) | 3,190 ( 90) |
| 4....... | 94 | 32.5 | 6.8 | 5.00 | 4.6 | 1,925 ( 86) | 3,250 ( 92) |
| 4....... | 141 | 32.2 | 7.3 | 4.75 | 4.4 | 1,995 ( 90) | 3,400 ( 96) |
| 4....... | 188 | 31.9 | 9.0 | 4.75 | 4.0 | 1,880 ( 84) | 3,575 (101) |

[1] In mixes containing more than 94 lb/cu yd, sand weights were reduced to compensate for increase in fly ash (by absolute volume).
[2] Each strength value is generally the average for four cylinders. Values in parentheses indicate percentages of control mix values.

Extensive experience at TVA in the use of fly ash in all classes of concrete led to development of a method for proportioning fly ash and cement to produce concrete with 28- and 90-day strengths equivalent to concrete without fly ash (15). (See appendix A.) The method is said to be readily adaptable to different strengths of Types I and II cement and to different quality fly ashes. The American Concrete Institute Guide, ACI 613-54, is also recommended reading on the subject. Furthermore, existing concrete technology is useful as a guide in proportioning concrete mixtures containing fly ash to obtain reasonably accurate predictions of compressive strength and other properties (36). Table 4 gives information from field experience and laboratory studies on proportioning concrete mixes made with and without fly ash (36) and indicates the maximum amount of portland cement that can be removed from 4- and 6-bag mixes and the amount of fly ash needed to compensate for early-strength loss due to removal of the cement. As seen in table 4, an essentially straight-line relationship exists between the amount of cement removed and the amount of fly ash needed for equal strength. Also, the ratios of sand to total aggregate for the fly ash mixes with 1-1/2-in. maximum aggregate were 0.02 below the values for the concrete mixes without fly ash and 0.04 less for the concrete with 3/4-in. maximum aggregate. Mixes containing fly ash and 3/4-in. maximum aggregate required about 3.8 gallons less water per cubic yard of concrete than comparable mixes made without fly ash to achieve a slump of 4 to 5 in.; the decrease for mixes with 1-1/2-in. maximum aggregate was about 2.8 gal/cu yd of concrete.

TABLE 4. - Mix proportions for fly ash concrete to obtain equal compressive strengths at 28 days

| Maximum size coarse aggregate, in. | Original mix | | Portland cement removed, lb | Fly ash adjusted mix | | |
|---|---|---|---|---|---|---|
| | Cement factor, sacks/cu yd | Sand ratio | | Cement factor, sacks/cu yd | Fly ash added, lb | Sand ratio |
| 1-1/2......... | 4.0 | 0.40 | 94.0 | 3.00 | 150 | 0.38 |
| 3/4......... | 4.0 | .46 | 94.0 | 3.00 | 175 | .42 |
| 1-1/2......... | 4.5 | .39 | 88.0 | 3.56 | 138 | .37 |
| 3/4......... | 4.5 | .45 | 88.0 | 3.56 | 156 | .41 |
| 1-1/2......... | 5.0 | .38 | 83.0 | 4.12 | 125 | .36 |
| 3/4......... | 5.0 | .44 | 83.0 | 4.12 | 137 | .40 |
| 1-1/2......... | 5.5 | .37 | 77.0 | 4.68 | 113 | .35 |
| 3/4......... | 5.5 | .43 | 77.0 | 4.68 | 118 | .39 |
| 1-1/2......... | 6.0 | .36 | 70.5 | 5.25 | 100 | .34 |
| 3/4......... | 6.0 | .42 | 70.5 | 5.25 | 100 | .38 |

Table 5 compares compressive strengths of concretes made with and without fly ash over a nominal range of 4 to 6 sacks per cubic yard (36). The 28-day strengths using gravel aggregates of both top sizes were greater for the fly ash blends than for their straight portland cement counterparts in the lean (4 and 4.5 bags/cu yd) mixes and lower in the richest (6 bags/cu yd) mix. These investigators concluded:

1. To obtain approximately equal compressive strength at early ages, between 3 and 28 days, mixes made with fly ash must have a total weight of portland cement and fly ash greater than the weight of the cement used in the comparable straight portland cement mixes. The latter mixes will, however, contain from three-quarters to 1 sack more cement per cubic yard of concrete.

2. The maximum amount of fly ash should be used with lean concretes. With the materials used in these tests, 175 lb of fly ash was used to replace 1 sack of cement per cubic yard of concrete in a nominal 4-sack mix, while 100 lb of fly ash was used to replace three-quarters sack of cement per cubic yard of concrete in a nominal 6-sack mix. The actual amounts will vary with the type of fly ash and aggregates used as well as with the richness of the mix.

3. The ratios of sand to total aggregate for mixes made with fly ash should be reduced from 0.02 to 0.04 below those used in comparable straight portland cement mixes having equal early compressive strengths.

4. With relatively few check tests, mix proportions for concrete containing a given fly ash and a given set of aggregates can be developed that will give results which may be predicted with reasonable accuracy.

It thus appears that cement and sand replacement can be adjusted to establish a fly ash-cement ratio without reducing the cement content of the mix to the point where the strength of the concrete suffers.

TABLE 5. - Concrete[1] made with gravel aggregate

| Mix[2] [3] | Nominal cement content, sacks/cu yd | Materials/cu yd[4] | | | | | w[6]/cement plus fly ash, lb/lb | Unit weight, lb/cu ft | Ultimate compressive strength, psi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cement, sacks | Fly ash, lb | Fine aggregate, lb | Coarse aggregate, lb | Water,[5] lb | | | 1 day | 3 days | 28 days |
| A | 4.0 | 3.98 | 0 | 1,540 | 1,805 | 331 | 0.79 | 150.1 | 273 | 786 | 2,470 |
| B | 4.5 | 4.47 | 0 | 1,480 | 1,815 | 331 | .70 | 149.8 | 355 | 1,020 | 3,090 |
| C | 5.0 | 5.00 | 0 | 1,435 | 1,820 | 327 | .62 | 150.2 | 482 | 1,305 | 3,750 |
| D | 5.5 | 5.50 | 0 | 1,390 | 1,835 | 322 | .55 | 150.7 | 572 | 1,595 | 4,055 |
| E | 6.0 | 5.98 | 0 | 1,340 | 1,850 | 324 | .51 | 151.0 | 716 | 1,910 | 4,835 |
| F | 4.0 | 3.03 | 175 | 1,450 | 1,940 | 289 | .54 | 151.9 | 266 | 886 | 3,135 |
| G | 4.5 | 3.59 | 156 | 1,360 | 1,965 | 288 | .50 | 152.4 | 314 | 1,080 | 3,425 |
| H | 5.0 | 4.13 | 137 | 1,310 | 1,965 | 297 | .49 | 152.0 | 370 | 1,345 | 3,720 |
| I | 5.5 | 4.68 | 118 | 1,260 | 1,970 | 301 | .47 | 151.5 | 417 | 1,605 | 4,015 |
| J | 6.0 | 5.25 | 100 | 1,220 | 2,000 | 308 | .45 | 152.4 | 499 | 1,870 | 4,190 |
| K | 4.0 | 4.02 | 0 | 1,370 | 2,045 | 308 | .71 | 152.0 | 371 | 1,170 | 3,095 |
| L | 4.5 | 4.51 | 0 | 1,310 | 2,055 | 309 | .62 | 152.0 | 456 | 1,345 | 3,260 |
| M | 5.0 | 5.03 | 0 | 1,275 | 2,075 | 308 | .56 | 152.8 | 600 | 1,575 | 4,115 |
| N | 5.5 | 5.51 | 0 | 1,220 | 2,080 | 305 | .51 | 152.6 | 729 | 1,860 | 4,570 |
| O | 6.0 | 5.99 | 0 | 1,180 | 2,090 | 300 | .46 | 153.2 | 782 | 2,095 | 4,940 |
| P | 4.0 | 3.03 | 152 | 1,295 | 2,110 | 276 | .54 | 152.8 | 242 | 1,200 | 3,295 |
| R | 4.5 | 3.59 | 139 | 1,250 | 2,125 | 278 | .50 | 153.1 | 297 | 1,280 | 3,575 |
| S | 5.0 | 4.15 | 126 | 1,205 | 2,135 | 286 | .47 | 153.2 | 360 | 1,545 | 3,805 |
| T | 5.5 | 4.70 | 113 | 1,155 | 2,140 | 287 | .44 | 153.2 | 444 | 1,815 | 4,145 |
| U | 6.0 | 5.25 | 100 | 1,105 | 2,150 | 288 | .41 | 153.3 | 582 | 1,965 | 4,460 |

[1] Slump, 4 to 5 in.
[2] Mixes, A to J made with 3/4-in. maximum size gravel.
[3] Mixes, K to U made with 1-1/2-in. maximum size gravel.
[4] Aggregates, air dry.
[5] Total water added.
[6] w = net water = water added minus water absorbed by aggregates.

Durability

Freezing-thawing tests of fly ash concrete indicate that a product deficient in entrained air, if cured in less than 90 days before freezing starts,

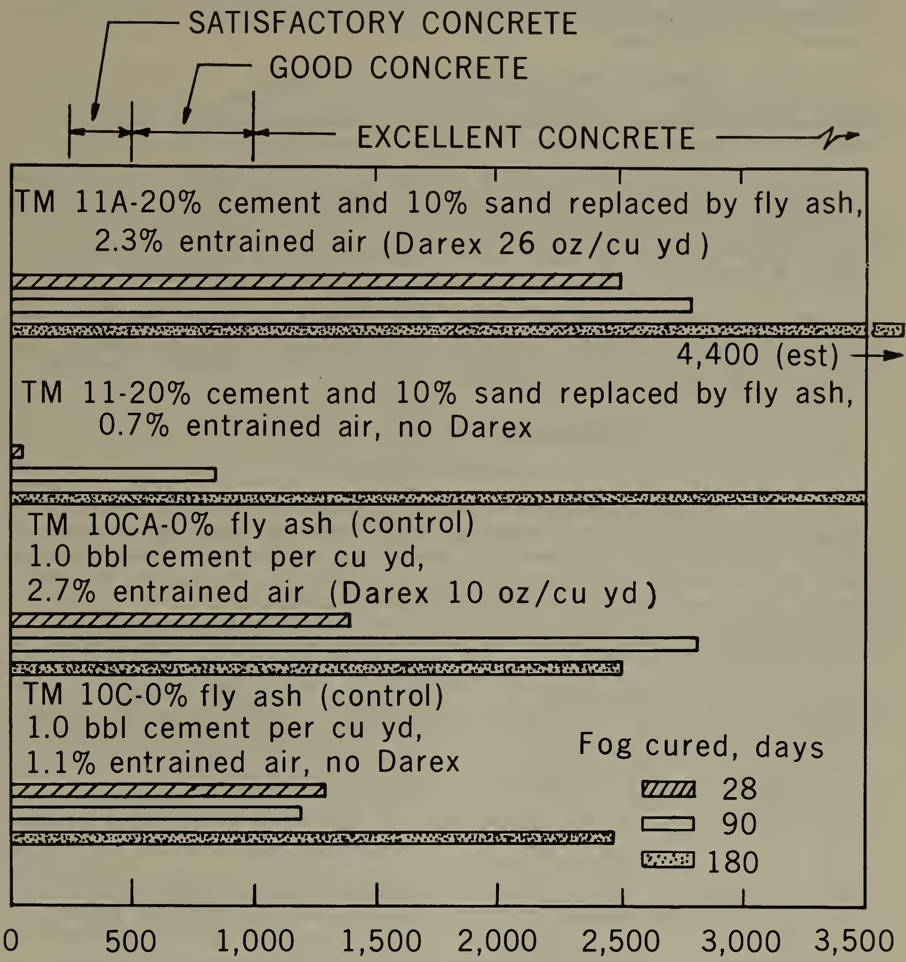


FIGURE 3. - Durability Tests of Concretes Containing Varying Amounts of Entrained Air.

will fail at a much lower number of freeze-thaw cycles than regular concrete, figure 3 (34). An air-entraining solution must be added to fly ash concrete, therefore, to obtain adequate durability on specimens cured less than 90 days before freezing. The tests on which figure 3 is based also indicated that a mix containing 2.3 percent intentionally entrained air makes a fly ash concrete that is more durable than regular concrete containing no intentionally entrained air at all ages.

In tests comparing the percent decrease or change in the dynamic modulus of elasticity (72), air-entrained concretes with or without fly ash proved equally frost resistant, indicating that air entrainment rather than fly ash content is the controlling factor that determines this property.

Investigators at Pennsylvania State University also conducted freeze-thaw experiments in the field, showing that the durability of concrete with 20 percent of the cement replaced with fly ash and 4 percent entrained air is comparable to standard concrete[4] (50). They, too, emphasized the importance of air content on durability. Resistance to rapid freezing and thawing was found to vary directly with the air content when the amount of air entrained was below 4 percent. Fly ash concrete maintained its strength better during 300 freeze-thaw cycles than did standard concretes, but the former suffered slightly more surface deterioration. Maximum weight loss of any test specimen (4 percent air) after 300 cycles was approximately 3 percent.

## Disadvantages of Fly Ash in Concrete

### Materials Handling

Materials handling problems in the utilization of fly ash in concrete are of more concern in regard to technology than economics. Although the fly ash producer may need some additional equipment, the cost of same is not prohibitive. The properties that make the fly ash utilization in concrete desirable, however, may cause handling difficulties if not planned for at the outset. Easy flowability, for instance, may cause problems in feeding and weighing, and the extreme fineness of fly ash can introduce air pollution and other problems, such as insulating of contacts in electrical boxes and switches. Proper design of feeders and scales and the installation of dust-collecting systems will eliminate these problems.

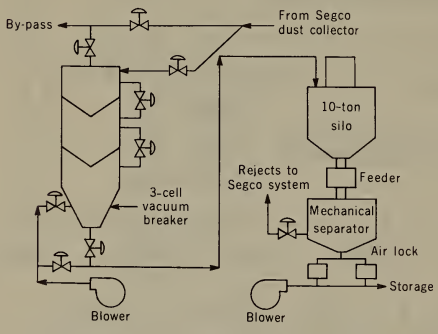


FIGURE 4. - Fly Ash Collection System.

Control of the fineness of the fly ash can pose problems for the producer or marketer. One producer, for example, uses the large mechanical separator shown in figure 4 to upgrade the fly ash that passes

[4] Standard class AA pavement mix, Pennsylvania Department of Highways.

through electrostatic precipitators (65). Operating in conjunction with these separators is a 3-cell vacuum breaker, a 10-ton holding silo, and a rotary feeder. Fine particles are removed and sent to the storage bins; the coarse particles are returned for disposal. Proper adjustment of the mechanical separator can make a 99-percent-through-200-mesh product without destroying the spherical shape of the particle. This is particularly important for ash for concrete.

## Air-Entraining Agent Requirement

As indicated, most fly ash concretes require more air-entraining agent to achieve a given air content than is required for regular concrete. Researchers at Battelle Memorial Institute have shown that the agent is adsorbed on and within the fly ash particle, where the agent cannot entrain air or interfere with hydration of the cement. Increasing the amount of agent to compensate for the quantity adsorbed by the fly ash achieves the desired air content, and the resultant product is as resistant to freezing-thawing or salt scaling as is regular air-entrained concrete.

Other investigations have shown that for a given mix the amount of the agent must be decreased with decreased concrete temperature (72). It was also determined that the increase in agent requirement with increase in fly ash quantity in the mix varies with different fly ashes. A correlation appears to exist between agent requirement and the carbon content of the fly ash (68). Agent requirement for constant air content was found to increase with carbon content and with the quantity of fly ash used as a replacement for portland cement.

Reading (56) presents considerable information on the technology of air entrainment in concrete.

## Specifications

Specifications for fly ash in concrete, bituminous pavement, and lightweight aggregate should be the performance type, expressed in terms of characteristics of the final product. Performance-type specifications are not presently practical, however, since years are required to determine if fly ash meets the standard. Fly ash specifications, therefore, are usually expressed in terms of fly ash characteristics believed to be indicative of the properties of the products made from fly ash (63). Specifications are primarily based on experience with a limited number of fly ashes, however, so it is possible for a fly ash to meet a given specification but not produce an acceptable product or vice versa (34).

Table 6 shows some of the specifications for fly ash in concrete, including similar data for fly ashes which have been used in actual structural concrete (71).

TABLE 6. - Chemical and physical characteristics of fly ash for use in concrete

| | $SiO_2$ (min), percent | $Al_2O_3$ (min), percent | MgO (max), percent | $SO_3$ (max), percent | Ignition loss (max), percent | $H_2O$ (max), percent | Alkalies (max), percent | Specific surface (min), sq cm/g | Retained 325 (max), percent | Specific gravity | Comparative strength (min), percent[1] | Shrinkage (max), percent | Expansion (max), percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIFICATIONS | | | | | | | | | | | | | |
| ASTM Specification C618-68T.. | 70 | ([2]) | - | 5 | 12 | 3 | 1.5 | 2,800 | - | - | 100 | 0.10 | 0.50 |
| Bureau of Reclamation.... | 70 | ([2]) | 3 | 4 | 5 | 3 | - | 3,000 | 12 | - | 85 | .03 | - |
| Flaming Gorge Dam............ | 75 | ([2]) | 5 | 4 | 5 | 3 | 2 | 3,000 | 15 | - | 85 | .04 | - |
| Preist Rapids Dam............ | 50 | - | - | - | 10 | 3 | 1.5 | - | 12 | - | 75 | .15 | - |
| Intrusion Prepakt Co..... | 40 | 15 | 3 | 3 | 5 | 2 | - | 3,000 | 12 | 2.3 (min) | - | - | - |
| City of Chicago. | 42 | 15 | 3 | 3 | 6 | 1 | - | 3,000 | 12 | - | - | - | - |
| Hungry Horse Dam | 40 | 15 | - | - | - | - | - | 3,000 | - | - | - | - | - |
| Sutton Dam...... | 70 | ([2]) | 3 | 3 | 6 | 3 | 1.5 | 2,800 | - | - | 75 | .03 | .50 |
| ACTUAL FLY ASHES | | | | | | | | | | | | | |
| Average of 34 ashes[3]...... | 44.1 | 20.8 | 1.2 | 1.3 | 7.8 | - | - | 3,673 | - | 2.4 | - | - | - |
| Dan River No. 3: | | | | | | | | | | | | | |
| Test 1........ | 49.6 | - | .94 | Trace | 5.3 | 0.05 | 0.92 | 2,500 | - | 2.15 | 150 | 0.03 | 0.07 |
| Test 2........ | 44.2 | - | 1.23 | .25 | 10.1 | .16 | .58 | 3,090 | - | 2.06 | 122 | .08 | .03 |
| Test 3........ | 45.5 | - | 1.17 | Trace | 10.9 | .04 | - | 3,665 | - | - | 116 | .04 | .01 |
| Allen No. 2:[4] | | | | | | | | | | | | | |
| Test 1........ | 47.0 | - | 1.26 | Trace | 6.0 | .09 | .81 | 8,685 | - | - | - | - | - |
| Test 2........ | 44.8 | - | 1.64 | .17 | 3.1 | .04 | .60 | 1,610 | - | 2.19 | 144 | .08 | .01 |
| Test 3........ | 45.3 | - | 1.97 | Trace | 3.7 | .05 | - | 2,660 | - | 2.25 | 113 | .05 | .07 |
| Colbert, TVA[4]... | 42.5 | 18.8 | 1.1 | .9 | 3.5 | - | .40 | 1,750 | 40 | 2.46 | - | - | - |

[1]Compressive strength of fly ash mix at 28 days is the listed percent of the control mix with no fly ash.
[2]Figure in the $SiO_2$ column is the minimum total for $SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$.
[3]Minimum $SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$ is 82.4 pct.
[4]Mechanical fly ash collectors.

Standards of the American Society for Testing and Materials (ASTM) cover fly ash for use in concrete in which the binding medium is entirely or partly portland cement. Among these are C618, Tentative Specifications for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete (1968); C340, Specifications for Portland-Pozzolan Cement (1954); C90, Specifications for Hollow Load-Bearing Concrete Masonry Units; C270, Specifications for Mortar for Unit Masonry; and C593, Specifications for Fly Ash and Other Pozzolans for Use With Lime (formerly covered by C379 and C432). Reference is made to use of fly ash in C94, Specifications for Ready Mixed Concrete, and C387, Specifications for Packages, Dry, Combined Materials for Mortar and Concrete. These specifications are said to prove satisfactory for evaluating fly ash as an admixture in concrete (45).

Since the coarser particles of fly ash somewhat decreases the workability of concrete, fly ash must be added in excess of the amount of cement replaced to get good workability and adequate strength. Some fly ash producers (electrically precipitated ash) recommend adding 1-1/2 lb of fly ash per lb of cement replaced. Excess volume resulting from this addition is compensated for by a corresponding reduction in the amount of sand added to the mix. The coarse fraction--+325 mesh--can be substituted for fine sand.

## Cost

The economy of using fly ash depends almost entirely on its quality and its cost relative to cement, although economic advantages may also accrue from less pouring time and less finishing time than for standard concrete (31).

Fly ash in one instance was used at a savings of 44¢/cu yd (15), as illustrated in table 7. In another instance, use of fly ash saved considerable money on a major construction project (10). In the latter instance, about 87 percent of the delivered cost of fly ash consisted of shipping charges, yet the ash still cost only about one-half the cost of portland cement. Significant savings can result when large quantities of concrete are involved. In the case mentioned, savings of about $1,700,000 were realized in the cost of the cementing materials. Another author reported that fly ash can usually be furnished to ready-mix plants or concrete blocks plants at a delivered price of about $5 per ton, compared with the delivered price for cement of $20 per ton (25). A cost difference of this magnitude can result in savings of up to $1/cu yd of ready mix concrete.

Figures A-5 and A-6 in appendix A for 90- and 28-day strengths show proportions of an average fly ash required for minimum cost of cement plus fly ash, based on recommended average concrete strengths normally required to provide the minimum strength concrete indicated.

TABLE 7. - Comparative cost of fly ash concrete and standard concrete[1]

| Constituent | Weight, lb | Volume, cu ft | Cost, dollars | |
|---|---|---|---|---|
| | | | Per 100 lb | Total |
| Cement..... | 330 | 1.67 | 1.15 | 3.80 |
| | (404) | (2.04) | (1.15) | (4.63) |
| Fly ash.... | 165 | 1.10 | .29 | .48 |
| | (-) | (-) | (-) | (-) |
| Water...... | 240 | 3.84 | - | - |
| | (250) | (4.00) | (-) | (-) |
| Sand....... | 0 | - | - | - |
| | (94) | (.51) | (.10) | (.09) |
| Total... | 735 | 6.61 | - | 4.28 |
| | (748) | (6.61) | | (4.72) |

[1]Data in parentheses are for standard concrete.

## LIGHTWEIGHT AGGREGATE

Lightweight aggregate made from clay, shale, slag, and slate has been sold in large quantities for a number of years, but increasing use is being made of lightweight aggregates from sintered fly ash. Sintered fly ash is produced by heating ash pellets to about 2,300° F, a temperature that softens and agglomerates the pellets into a more useful form. Heat is provided by passing air through the loose fly ash to burn carbon that is already in the material or has been added in required amounts. Sintered ash particles may be irregular, spherical, or cylindrical in shape, vary considerably in size, and are normally brown or black in color.

Since raw fly ash is a finely divided material, it does not have to be pulverized before it is sintered, as do clays and shales. Also, fly ash usually contains carbon in amounts sufficient for the sintering reaction, which reduces fuel costs--a major cost factor with other types of lightweight aggregate. Furthermore, fly ash is obtained without mining, often from plants near the industrialized, populated areas that have the greatest potential demand for lightweight aggregates.

Problems in the production of lightweight aggregate from fly ash have stemmed mostly from variations in composition and fineness of the raw ash and the creation of dust. Carbon content variation has proved most troublesome in regard to equipment operation and production of a specification product. Fineness of fly ash makes it necessary to pelletize the material before sintering to avoid restriction of airflow through the raw fly ash bed. Pelletizing, in turn, requires mixing with water or some other substance, and again, variation in fineness of the ash makes it difficult to achieve the mixing and paste consistency suitable for pelletizing.

### Raw Fly Ash Properties and Specifications

Raw fly ashes vary considerably physically and chemically, depending on coal type, pulverizing method, combustion conditions in the boiler, and dust

collection methods. Carbon and iron content of the ash influence the optimum production rate and quality of the aggregate. A carbon content of 3 to 10 percent is usually regarded as satisfactory for sintering. A sinter cake that requires crushing may be produced where the carbon content exceeds 10 percent or is below that value if fluxing materials are present.

This can be avoided by adding clay, recycled sintered ash, or low-carbon fly ash to the feed mix. When clay is used, it is ordinarily mixed with dampened high-carbon fly ash. Excessive moisture in this mix must be avoided, however; hence, a minimum of water should be added with the clay. When a low-carbon fly ash is utilized, carbon is usually added to provide enough fuel for sintering. High-carbon fly ash, bituminous coal, anthracite, or coke breeze are usually utilized for this purpose. Iron oxide in fly ash acts as a powerful flux in the sinter mix and therefore plays an important part in the vitrification process. Excessive iron in the ash can be a problem. Aggregate made from high-iron ash may cause staining of the product in which the aggregate is used unless the iron is completely oxidized or separated prior to processing. Both methods are in use or under study for iron removal, including magnetic separation. Iron-removal costs may be partly offset by recovery of iron oxide for iron and steel manufacture and heavy-media solids for use in washing coal.

Although satisfactory aggregate can be made from raw fly ash, beneficiation of the ash is sometimes necessary to make it more suitable for lightweight aggregate. Minnick (47) points out the value of adding additives to raw fly ash to make a specification product.

A commercial fly ash processing plant has been designed to produce iron oxide particles, pozzolanic fines, and carbon, and beneficiate fines for conversion to lightweight aggregate (11). After separation from the fine (90 percent through 325 mesh), the coarse material (+325 mesh) is put through a magnetic separator for division into an iron concentrate (50 to 60 percent iron) and a feed (70 percent through 325 mesh) to the sintering process. Since this process is capable of using low-carbon fly ashes, excess carbon is removed from the sinter feed by screening and air separation.

## Sintering Process

Several commercial processes are available for manufacturing lightweight aggregate from fly ash. These processes are continuous and carry out essentially the same basic steps although they vary in certain respects. Fly ash sintering plant equipment includes ash bins, pelletizer, conveyors, sintering machine, draft fans, and fuel and ignition equipment (77). Sometimes crushers are needed, depending on characteristics of the fly ash and the product desired. Pelletizing and sintering are the major operations.

### Pelletizing

Pelletizing is the process by which finely divided fly ash is formed into shapes that have body but are porous enough to be sintered. Pellets are formed by revolving cone, disc, drum, or extrusion device. Shapes intended for sintering must be strong enough to withstand handling by feeders and

conveyors and the thermal shock of the sintering operation. A rounded shape is said to provide maximum workability and aggregate volume and to reduce cement requirement because of the lower surface-to-volume ratio. Pellet shapes also can be used for concrete block manufacture or crushed to make a better textured block with more body.

An additional advantage claimed for extruded-type pellets is that a graded material can be produced without the necessity of secondary processing after sintering.

Pellets ranging in size from one-quarter to three-quarters of an inch are preferred if the product is intended for structural concrete use (35). The need to sinter the inside portion of the pellets can limit pellet size. If the pellets have not been completely sintered, crushing of the aggregate may produce excessive fines. Uniform pellet size is essential to effective sintering into a product of uniform porosity.

A bonding material, generally water, is intimately mixed with ash and the material is formed into small balls or pressed into pellet shape.

Excessive breakage can result in poor distribution of air in the sintering bed, leading to high dust losses in the stack and low yields of sinter. Acceptable structure can be produced by using water in the range of 15 to 25 percent by weight, but sometimes additives are employed to imptove the strength. After the ash and water are thoroughly mixed, the product is conveyed to a bin that evens out irregularities in the fly ash feed (to the plant) and water rates. Water to the mix is automatically controlled in accordance with information from previous operations.

A feeder discharges material from the bin into conveyors leading to the pan of the pelletizer. Water sprays and aerator jets are utilized in conjunction with the conveyor for final adjustment of moisture content. Blending and mixing of the material also is effected between the feeder plate at the bin and the pelletizer pan. Water sprays are used on the pelletizer if necessary.

Pelletizing takes place on a bowl-shaped pan that is flat on the bottom and tapered in steps on the side. The pan is inclined and rotates at a speed of almost 8 to 16 rpm. The pan can be tilted from 49-1/2 deg. to 67 deg. in seven 2-1/2 deg. intervals. Angle of inclination and speed of rotation, along with feed rate and moisture content, determine the pellet size. From the pan, the pellets are distributed evenly over the moving grates of the sintering machine. Sometimes oversize or undersize pellets are recycled and reworked to the proper size.

In the extrusion process, cylindrical pellets are formed by means of modified equipment of the type commonly used in the ceramic industry.

## Sintering

Sintering may be carried out by any of several types of machines. Major types are the traveling grate, rotating horizontal kiln, stationary vertical

kiln, and batch-type grate. The first three are continuous and best suited for processing large tonnages of material.

Traveling grate machines, the only type currently employed for fly ash, are amenable to operating changes to compensate for differences in the charge. Such machines produce a fused-mass-type material, like cinders or clinkers, or a product similar to the pellets themselves. The damp pellets are dried when they first enter the sintering machine to prevent spalling (or even explosion) from rapid exposure to high temperatures. Dried pellets then proceed to an ignition section where combustion of the inherent fuel begins, assisted by strong drafts of air. Following ignition, the pellets are indurated for a time to achieve uniform burning. The pellets approach fusion as the carbon is consumed but retain their general shape.

Grate speeds, temperatures, and other process variables are varied as required by raw material and product characteristics and are usually determined from or confirmed by pilot-scale tests or process trials. Uniform increase in pellet temperature is essential.

Drying and ignition takes place under a refractory-lined hood in the first 20 or so feet of the grate. Burners in the drying section use fuel oil and combustible gas piped from the ignition area or natural gas. Temperature is about 800° F under the hood and about 2,200° F in the ignition zone where heat is again provided by oil and gas burners. A downdraft of air provides the oxygen for combustion of the carbon in the pellets. Temperatures are controlled by varying the fuel and air rates and by dampers in the exhaust and gas-recycling systems. The latter channels some gas to the system and some out the stack.

Material coming off the end of the grate, if in clinker form, is crushed to the desired size. Fines or unsintered material is screened and sent back through the machine.

In vertical-retort-type machines, the pelletized ash is fed into the top of a vertical chamber in which combustion takes place; sinter is drawn off at the bottom. The process operates continuously and no ignition is required other than that for the initial charge. About 4 percent carbon is said to be needed for combustion. Crushing of the clinker is effected after the sintering. Vertical-type machines are limited to lower production rates than the horizontal type, but less space is required and operating and power costs are lower.

Sintering plants can be operated most efficiently if run continuously on a 24-hour basis until a forced shutdown, as is typical of processes that utilize high temperatures. Cold startups in the morning on a one-shift basis then cooling at the end of the shift are costly in terms of fuel, labor, production time, and process efficiency. Moreover, early in startup periods, considerable amounts of unsintered product are lost and an increased production of fines places a burden on dust control and cycling equipment. In addition, equipment deterioration and maintenance is higher during startup, mainly because of the effects of temperature stresses from heating and cooling.

## Conveying

Fly ash in most sintering plants is conveyed by bucket elevators, screw conveyors, belt conveyors, air slides, or pneumatic pumping equipment. Screw conveyors are often preferable to move ash from storage to mixing equipment since this type of equipment best facilitates quantity control and dust suppression. Transfer between pelletizer and sintering machine is best accomplished by belt conveyor. Material bins are needed in sizes and numbers depending on plant throughput and specification of the raw fly ash. Fluidized transport can be effectively used, particularly to move fly ash from storage hoppers to process equipment. In some applications, it may pay to transport the product by conveyor belt to barge loading areas or to stockpiles that permit continuous operation.

## Dust Suppression

In fly ash sintering plants, dust can present operating problems and cause pollution if preventive steps are not taken. Insufficient water in the mix, for example, can lead to excessive dust production in pelletizing machines. Dust can also escape at various locations at feeders and mixers. However, excessive dust formation in the sintering machine can often be corrected by flow, pressure, and moisture adjustment. Also, water sprays can be effective when dust is formed at transfer points between screens, chutes, and conveyors and where the product is deposited in storage piles. In other cases, gaps through which the dust escapes can be closed.

Improper screening can produce excessive fines that require processing. Adjustment of screen size can provide the answer.

Sometimes, fines collected or accumulated along the process train are best returned to raw material bins for preparation and mixing instead of being returned directly back to the pelletizer.

## Aggregate Production Cost

Several years ago, Weinheimer (73) made a study of production cost of a 1,000-ton-per-day fly ash aggregate plant. He assumed that raw fly ash would be free and that only water was needed as a binder. To a powerplant, normal disposal costs exclusive of what would be required to deliver the ash to the sintering plant would be a credit to the sintering plant operation. Tables 8 and 9 summarize his findings.

Converting these values to 1968 figures, based on a 1968 plant cost index (Chemical Engineering) of 1.132 to adjust amortization, insurance, and taxes, and a 1968 Nelson cost index of 1.014 to adjust direct labor, fuel, power, etc., conversion cost per ton would be as follows:

| | |
|---|---|
| Direct labor, etc........ | $1.45 |
| Amortization, 10 years... | 1.07 |
| Insurance, taxes......... | .25 |
| | 2.80 |

TABLE 8. - Processing costs

(1,000 tons per day)

| Item: | Cost per ton |
|---|---|
| Operating labor[1] | $0.30 |
| Maintenance labor[2] | .15 |
| Fuel[3] | .40 |
| Power (18 kwhr at 0.01) | .18 |
| Repair material and supplies | .08 |
| Water, heat, and miscellaneous | .03 |
| Mobile equipment (including driver) | .10 |
| | 1.24 |
| Contingencies | .19 |
| | 1.43 |

[1]Labor rate, $3.00 per hour, including fringe benefits, at 0.1 man-hour per ton.
[2]Labor rate, $3.00 per hour, including fringe benefits, at 0.05 man-hour per hour.
[3]Natural gas and hard coal fines.

TABLE 9. - Conversion costs to lightweight aggregate

(1,000 tons per day)

| Item: | Cost |
|---|---|
| Direct labor, fuel, power, etc.[1] | $1.43 |
| Amortization, 10 years | .94 |
| Insurance and taxes | .25 |
| | 2.62 |

[1]See table 1.

Weinheimer in 1962 estimated a 1,000-ton-per-day lightweight aggregate plant (24 hours) to cost $3,110,000, exclusive of land cost and foundations which were estimated at about $250,000. (A 1,000-megawatt powerplant produces 1,000 tons of fly ash per day.) Transformed into 1968 values by application of a 1968 plant cost index (Chemical Engineering) of 1.132, an aggregate plant of this size is estimated to cost $3,520,000. Such a figure would vary considerably, of course, depending on labor costs, and some variation in other factors also would be expected to alter the total for specified locations. Chemical and physical characteristics of the fly ash, insofar as they affect sintering and pelletizing characteristics, are also of vital importance.

Large tonnage output is recommended for sinter plant operations because labor costs do not vary much over a broad range of plant size and output. Moreover, operation at near capacity is desirable to keep labor costs, a major cost item, to a minimum.

Fuel cost is a big item in sintering, hence, carbon content is very important. Addition of carbon to low-carbon ash requires additional bins and feeders. Fused sinter cake production instead of the pellet form probably would require cake-breaking equipment.

Competitive aspects of lightweight aggregate production, as in the case of other commodities, require careful study of all factors concerned before the capital for such a project can be committed. Where cinders are available for cinder block manufacture, lightweight aggregate from fly ash usually will not be competitive in price. Low-volume plants may be practical in some instances, but 500 tons of fly ash per day reportedly is the minimum economic capacity, and an even larger output is likely to be necessary.

Study of the market has revealed that fly ash aggregate ordinarily must be produced for sale at less than $4.00 per ton (FOB plant) in areas where other types of lightweight aggregate are in plentiful supply. This figure is based on fly ash being furnished to the sintering plant without cost and with no credit assigned the sintering operation for reduction in disposal costs.

## Aggregate Properties and Applications

Sintered fly ash aggregates are chemically similar to those made from expanded clay or shale. Physically, however, they are different, as shown in table 10, where the properties of sintered fly ash aggregates are compared with other lightweight aggregates (70). Depending upon the process used in their manufacture, sintered fly ash particles may be spherical, cylindrical, or irregular in shape. Sintered fly ash aggregates are inert, durable, and a cubic yard of concrete requires only 1,800 lb versus 3,000 lb/cu yd for the conventional gravel and sand mixture.

The pozzolanic strength of ground sintered fly ash was shown to be greater than the original ash. The additional pozzolanic activity demonstrated by the aggregate, it is claimed, contributes to the long-term strength developed by the product (47).

Unlike raw fly ash, sintered aggregates can be stockpiled outside during the winter to meet increased demands during the summer. Inside or covered storage is required for raw fly ash, which is impractical because of its relatively low selling price. Most tonnage markets for fly ash in concrete, soil stabilization, asphalt filler, and blocks exist during the summer months.

The market for sintered fly ash aggregate in structural and precast concrete is well established. The aggregate serves satisfactorily as a replacement for natural stone aggregates where minimum weight is of prime interest. Sintered fly ash aggregate gives about a 25-percent weight reduction in floors and columns, which in turn permits use of less reinforcing steel, easier handling, and lighter forms and foundations. Use of smaller columns also provides more floor space. The net effect can be significant savings in building costs. Use of fly ash in this manner supplements supplies of aggregate made from sintered shale, clay, slags, pumice, and cinders. Shortages of the latter have developed in recent years and supplies probably will continue to diminish. Moreover, shales, clays, slags, and pumice may not always be found near the market areas. Sintered fly ash can help alleviate this shortage.

Building blocks have accounted for most of the lightweight aggregate consumed in recent years, most of it made from clay and shale. Staining quality of sintered fly ash blocks have proved to be no less than that obtained with cinder blocks. Stain tests have shown 0.22 milligram of ferric oxide per 200 grams of aggregate, very light by ASTM classification.

TABLE 10. - Typical properties of lightweight aggregates (National Bureau of Standards)

| | Passing U.S. Standard sieve, wt pct | | | | | | | | | Weight, lb/cu ft | | Bulk specific gravity[1] | Absorption | | Grading[2] | Crushing strength[3] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3/4 in. | 1/2 in. | 3/8 in. | No. 4 | No. 8 | No. 16 | No. 30 | No. 50 | No. 100 | Rodding method | Jigging method | | Wt pct | By volume, lb/cu ft | | 1-in. compaction, psi | 2-in. compaction, psi |
| Expanded shale: | | | | | | | | | | | | | | | | | |
| Coarse.... | - | 100 | 84 | 11 | 2 | 2 | 1 | 1 | 1 | 60 | 65 | 1.7 | 7 | 5 | 1 | 2,120 | 16,500 |
| Fine...... | - | - | - | 100 | 99 | 71 | 46 | 31 | 20 | 76 | 79 | 2.1 | 8 | 6 | 1 | 2,120 | 16,500 |
| Expanded clay: | | | | | | | | | | | | | | | | | |
| Coarse.... | 100 | 71 | 21 | 1 | - | - | - | - | - | 36 | 35 | 1.2 | 20 | 7 | 1 | 1,100 | 4,220 |
| Fine...... | - | - | 100 | 85 | 25 | 2 | 1 | 1 | 1 | 35 | 38 | 1.2 | 27 | 10 | 2 | 1,100 | 4,040 |
| Expanded slate: | | | | | | | | | | | | | | | | | |
| Coarse.... | - | 100 | 99 | 55 | 11 | 5 | 3 | 2 | 2 | 39 | 41 | 1.3 | 15 | 6 | 1 | 635 | 2,120 |
| Fine...... | - | - | - | 100 | 90 | 61 | 38 | 21 | 10 | 73 | 72 | 2.2 | 8 | 7 | 1 | 635 | 2,120 |
| Sintered fly ash: | | | | | | | | | | | | | | | | | |
| Coarse.... | 100 | 91 | 58 | 11 | 8 | 8 | 7 | 7 | 5 | 42 | 45 | 1.7 | 15 | 6 | 1 | 325 | 1,100 |
| Fine...... | - | - | 100 | 85 | 58 | 37 | 24 | 15 | 10 | 58 | 66 | 2.1 | 8 | 1 | 1 | 325 | 1,100 |
| Expanded slag: | | | | | | | | | | | | | | | | | |
| Coarse.... | - | 100 | 81 | 13 | 7 | 6 | 6 | 5 | 4 | 48 | 50 | 2.0 | 23 | 10 | 1 | 240 | 1,040 |
| Fine...... | - | - | 100 | 96 | 77 | 52 | 30 | 17 | 10 | 61 | 71 | 2.3 | 8 | 6 | 1 | 240 | 1,040 |
| Pumice: | | | | | | | | | | | | | | | | | |
| Coarse.... | [4]93 | 64 | 48 | 34 | 25 | 20 | 16 | 12 | 9 | 44 | 33 | 1.5 | 43 | 17 | 1 | 485 | 1,710 |
| Fine...... | - | - | 100 | 89 | 71 | 54 | 40 | 30 | 21 | 49 | 53 | 1.7 | 29 | 15 | 1 | 485 | 1,710 |
| Expanded vermiculite | - | - | 100 | 99 | 95 | 77 | 38 | 7 | 1 | 10 | 9 | 1.4 | 129 | 19 | 2 | 10 | 40 |

[1]Determined on saturated-surface dry aggregate, ASTM C128-42.
[2]The two gradings, No. 1 and No. 2, with sieve sizes according to ASTM Standard Specifications, E11-39, are listed below:

| Grade | Sieve-size limits | Wt pct |
|---|---|---|
| 1 | 3/8 in. to No. 4 (0.187 in.)............ | 50 |
| | No. 4 (0.187 in.) to No. 8 (0.0937 in.).. | 30 |
| | No. 8 (0.0937 in.) to No. 16 (0.0469 in.) | 20 |
| | Total............................ | 100 |
| 2 | No. 4 (0.187 in.) to No. 8 (0.0937 in.).. | 60 |
| | No. 8 (0.0937 in.) to No. 16 (0.0469 in.) | 40 |
| | Total............................ | 100 |

[3]Tests made with 3-1/32-in.-diameter by 6-in. cylinder and 3-in.-diameter piston; steel construction.
[4]100 pct passed through a 1-in. screen.

## LIGHTWEIGHT AGGREGATE CONCRETE

Aggregates made from fly ash, clay, shale, slag, or slate serve as base material for the manufacture of lightweight concrete. As estimated, 15 million tons of aggregate is used annually for this purpose, and consumption within the next decade is expected to exceed 50 million tons per year. Although lightweight aggregate production accounted for only about 150,000 tons of the fly ash utilized in 1967, barely 10 percent of the ash marketed that year, production of aggregate from fly ash is a potentially multimillion-ton outlet for the solid waste.

Sintered fly ash aggregate is suitable for making a variety of lightweight structural concretes ranging in strength from 1,000 to more than 4,000 psi. Compared with the other types of lightweight aggregates (expanded clays, shales, vermiculites, slags, and pumices), fly ash aggregate concretes provide moderate insulation, very good resistance to freezing and thawing, and moderate drying shrinkage. Fly ash aggregate concrete weighs from 80 to 115 lb/cu ft, and the workability of the product is fair to good, giving a smooth, finished surface (70). Typical data on mixes and properties of mixtures are given in tables 11 and 12 (47).

TABLE 11. - Typical data on fly ash aggregate lightweight concrete mixes

| Cement, sacks/cu yd | Dry aggregate, lb/cu yd | | Total water, gal/cu yd | Air-entraining agent, oz/sack |
|---|---|---|---|---|
| | Coarse | Fine | | |
| EXTRUDED LIGHTWEIGHT COARSE AGGREGATE[1] WITH NATURAL CONCRETE SAND | | | | |
| 5.00 | 875 | 1,290 | 52.5 | 1.75 |
| 6.05 | 875 | 1,230 | 53.8 | 1.75 |
| 6.92 | 875 | 1,190 | 54.4 | 2.00 |
| PELLETIZED LIGHTWEIGHT COARSE AGGREGATE[2] WITH NATURAL CONCRETE SAND | | | | |
| 4.90 | 985 | 1,300 | 49.2 | 1.75 |
| 5.90 | 985 | 1,195 | 54.5 | 2.00 |
| EXTRUDED LIGHTWEIGHT COARSE AND FINE AGGREGATES[3] | | | | |
| 6.92 | 645 | 1,062 | 70.3 | 4.00 |
| 6.93 | 786 | 871 | 68.4 | 4.00 |
| PELLETIZED LIGHTWEIGHT COARSE AND FINE AGGREGATES[2] | | | | |
| 6.86 | 591 | 971 | 67.0 | 6.00 |
| 6.99 | 753 | 830 | 64.3 | 6.00 |

[1]Fly ash aggregate 42 lb/cu ft.
[2]Fly ash aggregate 48 lb/cu ft.
[3]Fly ash aggregate 53 lb/cu ft.

TABLE 12. - Properties of concrete mixtures in table 11

| Cement, sacks/ cu yd | Slump, in. | Total air, pct | Comparative workability | Bleeding | Plastic concrete, lb/cu ft | Compressive strength (7 days), psi |
|---|---|---|---|---|---|---|
| EXTRUDED LIGHTWEIGHT COARSE AGGREGATE WITH NATURAL CONCRETE SAND | | | | | | |
| 5.00 | 3.5 | 6.5 | Very good.. | None....... | 113.8 | 2,940 |
| 6.05 | 3.0 | 5.5 | ....do..... | None....... | 116.0 | 3,705 |
| 6.92 | 3.0 | 5.0 | ....do..... | None....... | 117.0 | 4,307 |
| PELLETIZED LIGHTWEIGHT COARSE AGGREGATE WITH NATURAL CONCRETE SAND | | | | | | |
| 4.90 | 3.8 | 5.5 | Good....... | Slight..... | 117.0 | 2,690 |
| 5.85 | 3.5 | 5.0 | Good....... | Very slight | 117.5 | 3,277 |
| EXTRUDED LIGHTWEIGHT COARSE AND FINE AGGREGATES | | | | | | |
| 6.92 | 2.2 | 6.5 | Fair....... | Very slight | 109.0 | 3,520 |
| 6.93 | 2.0 | 7.5 | Fair....... | ....do..... | 107.6 | 3,410 |
| PELLETIZED LIGHTWEIGHT COARSE AND FINE AGGREGATES | | | | | | |
| 6.86 | 2.2 | 6.7 | Fair....... | Slight..... | 102.6 | 3,060 |
| 6.99 | 2.0 | 5.4 | Fair....... | Very slight | 102.8 | 3,430 |

## Physical Properties

### Plastic Concrete

Pfeifer (53) found that physical properties of structural lightweight concretes made with commercial fly ash aggregates compare favorably with those of other types of lightweight aggregate concrete. Moreover, the properties fall within the guidelines established by the American Concrete Institute for structural lightweight aggregate concrete (3). Under the conditions of Pfeifer's tests, plastic concretes containing only coarse and fine fly ash aggregate were difficult to cast because of the grading characteristics of the fly ash aggregate, but replacement of fly ash fines with natural sand made a concrete that was quite workable. Replacement of at least one-third of the fly ash aggregate fines was required. It was found that large amounts of air-entraining agent were required to entrain 6 percent air when fly ash aggregate fines were used (53). Fineness of the aggregate, most of which ran 15 to 20 percent through No. 100 screen, was mostly responsible for this trend. Plastic concretes in which one-third, two-thirds, and all of the fly ash fines were replaced with sand had unit weights that ranged from 104 to 108, 110 to 115, and 115 to 121 lb/cu ft (1,666 to 1,730, 1,762 to 1,842, and 1,842 to 1,938 kg/cu m), respectively. All concretes were proportioned to have a slump of 2 to 3 in. (5 to 8 cm), measured air contents of 5 to 7 percent, and portland cement contents ranging from 376 to 940 lb/cu yd (223 to 558 kg/cu m).

### Hardened Concrete

Compressive strength (28 days), elasticity moduli, and unit weight data on hardened concretes made with fly ash aggregate[5] are given in figure 5 and

[5]Aggregates 1, 2, and 4--ash pelletized in inclined rotating pans, fired on sintering grate. Spherically shaped.
Aggregate 3--ash extruded and fired on sintering grate. Cylindrically shaped.
Sand--normal weight, Elgin, Ill.

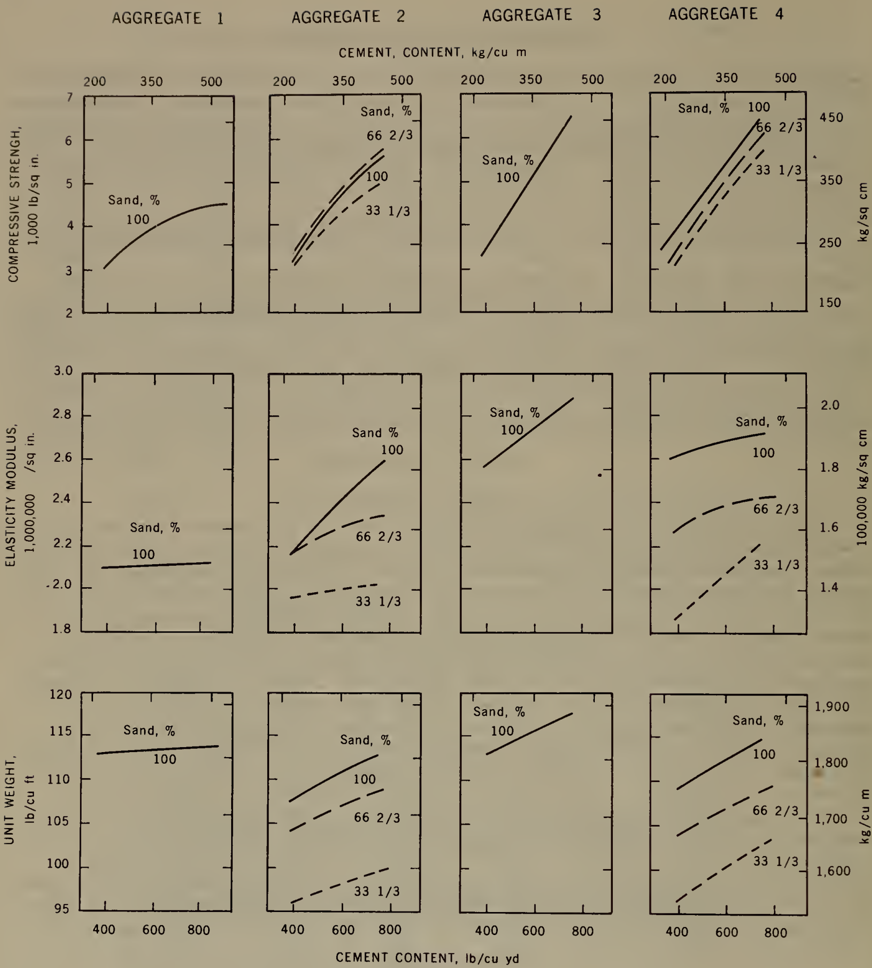


FIGURE 5. - Compressive Strength, Modulus of Elasticity, and Unit Weight as Function of Cement and Sand Content (53).

tables 13 and 14 (53). Compressive strength (determined by ASTM procedure C39-66) of most of the concretes tested increased rather uniformly with increase in both portland cement and sand content. The 28-day compressive strengths range from 3,000 to 6,500 psi (211 to 456 kg/cm$^2$).

TABLE 13. - Measured compressive strength, modulus of elasticity, and unit weight of concretes[1]

| Replacement of fines with sand, pct | Nominal cement content,[2] bags/cu yd | Compressive strength, psi | | Modulus of elasticity, $10^6$ psi | | Unit weight, lb/cu ft | | |
|---|---|---|---|---|---|---|---|---|
| | | 7 days | 28 days | 7 days | 28 days | Plastic | 7 days | 28 days |
| AGGREGATE 1 CONCRETE | | | | | | | | |
| 100 | 4 | 1,890 | 2,980 | 1.73 | 1.98 | 120 | 121 | 111 |
| 100 | 6 | 2,960 | 4,110 | 1.86 | 2.30 | 119 | 120 | 115 |
| 100 | 8 | 3,190 | 3,970 | 1.90 | 1.96 | 117 | 118 | 112 |
| 100 | 10 | 3,980 | 4,630 | 2.02 | 2.02 | 119 | 119 | 115 |
| AGGREGATE 2 CONCRETE | | | | | | | | |
| 33.3 | 4 | 1,550 | 2,860 | 1.64 | 1.95 | 108 | 107 | 96 |
| 33.3 | 6 | 2,390 | 3,860 | 1.76 | 1.93 | 104 | 104 | 96 |
| 33.3 | 8 | 3,860 | 4,970 | 2.01 | 1.83 | 106 | 106 | 101 |
| 66.6 | 4 | 1,880 | 3,280 | 1.81 | 2.22 | 115 | 113 | 104 |
| 66.6 | 6 | 3,510 | 4,960 | 2.14 | 2.51 | 114 | 114 | 108 |
| 66.6 | 8 | 4,350 | 5,600 | 2.31 | 2.33 | 113 | 112 | 108 |
| 100 | 4 | 1,970 | 3,020 | 1.47 | 2.10 | 116 | 116 | 108 |
| 100 | 6 | 3,290 | 4,410 | 2.15 | 2.23 | 115 | 116 | 111 |
| 100 | 8 | 4,690 | 5,450 | 2.37 | 2.59 | 116 | 117 | 113 |
| AGGREGATE 3 CONCRETE | | | | | | | | |
| 100 | 4 | 1,780 | 3,490 | 1.89 | 2.51 | 120 | 122 | 113 |
| 100 | 6 | 3,460 | 5,050 | 2.49 | 2.73 | 120 | 121 | 115 |
| 100 | 8 | 5,270 | 6,520 | 2.91 | 2.86 | 121 | 122 | 118 |
| AGGREGATE 4 CONCRETE | | | | | | | | |
| 33.3 | 4 | 1,490 | 3,050 | 1.60 | 1.88 | 107 | 108 | 97 |
| 33.3 | 6 | 2,980 | 4,640 | 2.00 | 2.14 | 106 | 107 | 100 |
| 33.3 | 8 | 4,040 | 5,570 | 2.09 | 2.12 | 107 | 108 | 103 |
| 66.6 | 4 | 2,010 | 3,140 | 2.01 | 2.26 | 110 | 111 | 104 |
| 66.6 | 6 | 3,320 | 4,810 | 2.02 | 2.41 | 111 | 110 | 106 |
| 66.6 | 8 | 4,450 | 5,810 | 2.40 | 2.39 | 112 | 113 | 109 |
| 100 | 4 | 2,060 | 3,650 | 2.12 | 2.49 | 115 | 115 | 109 |
| 100 | 6 | 3,460 | 4,940 | 2.35 | 2.72 | 115 | 115 | 111 |
| 100 | 8 | 5,090 | 6,540 | 2.68 | 2.71 | 117 | 117 | 114 |

[1] Psi × 0.070307 = kg/sq cm; lb/cu ft × 16.0185 = kg/cu m.
[2] 94-lb bags/cu yd concrete.

Elasticity modulus (28 days) is affected by compressive strength and unit weight, both of which are significantly influenced by natural sand content. Measured values of elasticity ranged from 1.9 to 2.8 million psi (0.134 to 0.197 million kg/cm$^2$). When the compressive strength was about 5,000 psi (352 kg/cm$^2$), there was agreement with the ACI design equation, $E_c = 33w^{3/2}\sqrt{f'_c}$ (54). At 3,000 and 6,000 psi (211 and 422 kg/cm$^2$), however, the moduli ran about 10 and 20 percent higher, respectively, than calculated.

TABLE 14. - Measured compressive strength, modulus of elasticity, creep, and drying shrinkage of concretes[1]

| Aggregate | Replacement of fines with sand, pct | Compressive strength, psi | | Modulus of elasticity, $10^6$ psi | | Creep, 1 year | | Measured shrinkage at 1 year, $10^{-6}$ in./in. |
|---|---|---|---|---|---|---|---|---|
| | | 7 days | 28 days | 7 days | 28 days | Measured, $10^{-6}$ in./in. | Coefficient, $10^{-6}$/psi | |
| 1 | 100 | 1,790 | 3,070 | 1.81 | 2.16 | 860 | 1.13 | 610 |
| | 100 | 3,830 | 4,410 | 2.44 | 2.20 | 1,400 | .93 | 770 |
| 2 | 33.3 | 1,850 | 3,650 | 1.78 | 1.97 | 895 | 1.20 | 645 |
| | 66.6 | 2,270 | 3,420 | 1.94 | 2.15 | 775 | 1.03 | 570 |
| | 100 | 1,850 | 3,150 | 2.05 | 2.19 | 875 | 1.17 | 550 |
| | 33.3 | 3,980 | 5,200 | 1.92 | 2.03 | 1,320 | .88 | 825 |
| | 66.6 | 4,010 | 5,160 | 2.28 | 2.31 | 1,130 | .76 | 765 |
| | 100 | 3,990 | 5,270 | 2.31 | 2.52 | 1,220 | .81 | 760 |
| 3 | 100 | 1,810 | 3,180 | 2.18 | 2.59 | 705 | .94 | 445 |
| | 100 | 3,260 | 4,600 | 2.32 | 2.71 | 1,230 | .82 | 612 |
| 4 | 33.3 | 1,450 | 2,950 | 1.44 | 1.84 | 1,050 | 1.40 | 560 |
| | 66.6 | 1,680 | 3,110 | 2.09 | 2.27 | 630 | .84 | 530 |
| | 100 | 1,920 | 3,420 | 2.26 | 2.64 | 720 | .96 | 495 |
| | 33.3 | 3,050 | 4,470 | 1.83 | 2.25 | 1,415 | .98 | 795 |
| | 66.6 | 3,460 | 4,920 | 2.45 | 2.36 | 1,100 | .73 | 655 |
| | 100 | 3,940 | 4,650 | 2.32 | 2.62 | 1,115 | .74 | 570 |

[1] Psi × 0.070307 = kg/sq cm; $10^{-6}$ in./in./psi × 14.223 = $10^{-6}$ cm/cm/kg/sq cm.

Unit weight (28 days) increased more or less uniformly with increase in the sand content. For products containing one-third, two-thirds, and 100 percent sand, unit weight ranged from 96 to 103, 104 to 109, and 108 to 118 lb/cu ft (1,538 to 1,650, 1,666 to 1,716, and 1,730 to 1,890 kg/cu m), respectively. At a specified sand content, the unit weight increased by about 5 lb/cu ft (80 kg/cu m) as the portland cement content increased from 376 to 752 lb/cu yd (223 to 446 kg/cu m).

Average creep coefficients (1 year) of 5,000 psi concretes were about one-fourth less than coefficients for 3,000 psi concretes. Creep coefficients were reduced 14 to 40 percent when the sand content was increased from one-third to two-thirds. When the sand content was increased to 100 percent, the coefficients increased slightly. One-year creep values for 100 percent sand concrete ranged from 0.94 to 1.17 and 0.74 and 0.93 millionths/psi (13 to 17 and 10 to 13 millionths per kg/cu m), respectively, for 3,000 and 5,000 psi (211 and 352 kg/cu m) concretes. One-year creep values were 93 percent of 2-year values, which agrees with published data (54). Ultimate creep coefficients for the fly ash aggregate concretes of these tests could be estimated by multiplying 1-year creep values by 1.18 (54).

One-year drying shrinkage values for 5,000 psi concretes was about 30 percent more than for 3,000 psi concrete (table 14). Increasing the sand proportion reduced the drying shrinkage. Concretes containing 100 percent sand had 10 to 30 percent less shrinkage than those with one-third percent sand. One-year shrinkage figures for the four concretes containing 100 percent sand were 445 to 600 in.$^{-6}$/in. for 3,000 psi concrete and 570 to 700 in.$^{-6}$/in. for 5,000 psi concrete. One-year shrinkage values average about 96 percent of 2-year figures, with the ultimate determinable by applying a factor of 1.12 to the 1-year values.

Splitting tensile strengths of the concretes determined according to ASTM C496-66 are presented in table 15 (53). These data show that the splitting tensile strengths increased with increasing compressive strength of the concrete. Continuously moist-cured (28 days) fly ash aggregate concretes had splitting tensile strengths ranging from 90 to 120 percent of the comparable normal weight concrete made with Elgin, Ill., sand and gravel (53, 55). However, when the concretes were cured as specified by the American Concrete Institute Building Code,[6] the fly ash aggregate concretes had reduced splitting strengths (53, 55). The 3,000-psi fly ash concrete had splitting strengths ranging from 84 to 104 percent of the normal weight 3,000-psi concrete; the 5,000-psi fly ash concrete values ranged from 68 to 79 percent of the comparable concrete.

TABLE 15. - Measured splitting tensile strengths

| Aggregate | Replacement of fines with sand, pct | $f'_c$, psi | Splitting tensile strength, psi | | Splitting tensile strength ratio, air-dry/moist |
|---|---|---|---|---|---|
| | | | Air-dry[1] | Moist[2] | |
| 1 | 100 | 3,070 | 319 | 320 | 1.00 |
| | 100 | 4,410 | 375 | 443 | .85 |
| 2 | 33.3 | 3,650 | 313 | 403 | .78 |
| | 66.6 | 3,420 | 316 | 362 | .87 |
| | 100 | 3,150 | 311 | 302 | 1.03 |
| | 33.3 | 5,200 | 353 | 520 | .68 |
| | 66.6 | 5,160 | 366 | 486 | .75 |
| | 100 | 5,270 | 362 | 479 | .76 |
| 3 | 100 | 3,180 | 385 | 375 | 1.03 |
| | 100 | 4,600 | 392 | 460 | .85 |
| 4 | 33.3 | 2,950 | 325 | 333 | .98 |
| | 66.6 | 3,110 | 341 | 368 | .93 |
| | 100 | 3,420 | 369 | 348 | 1.06 |
| | 33.3 | 4,470 | 343 | 463 | .74 |
| | 66.6 | 4,920 | 377 | 491 | .77 |
| | 100 | 4,650 | 397 | 423 | .94 |

[1]7 days of moist curing followed by 21 days of drying at 73° F, 50 pct relative humidity.
[2]28 days of moist curing.

[6]Moist cured for 7 days followed by 21 days of air drying at 50 percent relative humidity (4).

Similar observations (55) have been made with other types of lightweight aggregate concretes.

Table 16 gives results of freeze-thaw tests (53). Air-entrained fly ash aggregate concretes proved quite durable; durability factors ranged from 91 to 101 after the 300-cycle test. One concrete (5,000 psi) made from spherically shaped fly ash aggregates had a low air content of only 3.8 percent and the resulting durability factor was reduced to 69. Compressive strength and sand content had little effect on expansion measurements, relative dynamic modulus of elasticity, and computed durability factors. Weight change characteristics were influenced by compressive strength level, and 5,000 psi concretes suffered lower weight loss than did the comparable 3,000-psi concrete.

TABLE 16. - Measured results of freezing and thawing test

| Aggregate | Replacement of fines with sand, pct | $f'_c$, psi | Air, pct[1] | Expansion at 300 cycles, pct | Change in weight at 300 cycles,[2] pct | Relative dynamic (E) at 300 cycles, pct | Durability factor (ASTM C290) |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 3,070 | 6.1 | 0.022 | -2.0 | 91 | 91 |
| | 100 | 4,410 | 3.8 | .046 | -.5 | 69 | 69 |
| 2 | 33.3 | 3,650 | 6.5 | .017 | +1.2 | 97 | 97 |
| | 66.6 | 3,420 | 6.0 | .015 | +.4 | 96 | 96 |
| | 100 | 3,150 | 6.4 | .018 | -4.7 | 91 | 91 |
| | 33.3 | 5,200 | 5.6 | .014 | +1.2 | 101 | 101 |
| | 66.6 | 5,160 | 5.7 | .012 | +1.8 | 100 | 100 |
| | 100 | 5,270 | 6.2 | .015 | +1.3 | 98 | 98 |
| 3 | 100 | 3,180 | 5.4 | .016 | -.8 | 97 | 97 |
| | 100 | 4,600 | 6.1 | .020 | +1.6 | 95 | 95 |
| 4 | 33.3 | 2,950 | 6.1 | .017 | [3]-5.9 | 91 | 91 |
| | 66.6 | 3,110 | 6.1 | .017 | [4]-7.9 | 92 | 92 |
| | 100 | 3,420 | 5.5 | .018 | -3.3 | 96 | 96 |
| | 33.3 | 4,470 | 6.2 | .013 | +.5 | 92 | 92 |
| | 66.6 | 4,920 | 6.3 | .013 | -.8 | 96 | 96 |
| | 100 | 4,650 | 6.6 | .018 | .0 | 96 | 96 |

[1]Roll-a-meter.
[2]All tests were terminated after 300 cycles.
[3]275 cycles.
[4]250 cycles.

## SOIL STABILIZATION AND BASE COURSE CONSTRUCTION

Soils, wet or dry, that exhibit marked and sustained resistance to deformation under repeated or continuing loads are said to be stable. Treatment of a soil to improve its strength and deformation resistance is referred to as

"stabilization." Some years ago, the term stabilization signified improvement in a qualitative sense only. More recently, however, the term has become associated with quantitative values of strength and durability as related to performance. Strength is expressed in terms of compression, shear, or some bearing value or load deflection value that indicates load-bearing quality. Durability is indicated in terms of absorption, softening, strength reduction, resistance to freezing and thawing, and wetting and drying.

Soil types have markedly different properties and react differently to stabilization methods. Therefore, several types of stabilization methods exist, along with wide ranges in the degree of stabilization. Stabilization is effected by mechanical, chemical, electrical, and thermal means, and the degree of stabilization varies within a given method and between methods. Commonly used chemical soil-stabilizing materials include portland cement, asphalt, tar, lime, calcium chloride, sodium chloride, and mixtures of lime and pozzolan. Upgrading the physical properties of fine-grained soils (silts, clays) through the use of lime-fly ash mixtures is one method of improving the performance of subgrades and subbases. Where the lime-fly ash mixture is used for base course construction, pavement design characteristics such as traffic load requirement and thickness must be considered. Outstanding performance from properly designed paving materials mixtures has been obtained (2, 9, 29).

Interest in fly ash to stabilize soils, particularly those underlying roads and other kinds of pavements, was stimulated by the relatively low cost of the powerplant waste and shortages in many areas of good, natural base course materials. Pavements with lime-fly ash-stabilized soils exist in Pennsylvania, Maryland, New Jersey, Iowa, Alabama, West Virginia, Michigan, and other States.

## Chemistry of Stabilization

Basic information on the pozzolanic properties of fly ash and lime in combination with aggregates have been evolved by several investigators. Minnick (48) has shown that variations in the lime and fly ash play a significant role in the chemical reactions. Major reactants in limes are calcium hydroxide and magnesium oxide, but at ambient temperature, carbonates or magnesium hydroxide do not significantly contribute to the pozzolanic reaction. Data from X-ray, DTA, and microscopic examination are in substantial agreement and indicate that the amorphous glassy materials within fly ashes react to form complex silicates and aluminates.

Some of the chemical and physical properties of lime, fly ash, and mixtures of the two correlate with important qualities of stabilized soil while others do not. In one study (79), no correlation was obtained between 7-, 28-, and 120-day strengths when lime-fly ash mixtures were cured at 70° F. Also, no correlation was found between the chemical composition of fly ash and the influence on 28-day strength of products made with various limes-lime-fly ash ratios. However, application of the triangular chart concept to the correlation of chemical composition with 28-day strength appeared to offer promising results. Chemical composition of fly ash expressed in mole fractions was found to correlate with strength better than chemical composition expressed in

weight-percent. Three factors--sieve analysis (No. 325 sieve), carbon content as determined by loss on ignition, and percent solids via compaction tests--also appeared to be fairly reliable criteria of fly ash quality for soil-lime-fly ash stabilization.

British investigators (67) who tested mortars composed of fly ash, sand, and lime, found very little or no correlation between compressive strength and such factors as carbon, silica, alumina, or glass content. They did, however, find that the specific surface of the fly ash, as determined by particle size analysis, had a direct effect on pozzolanic activity.

Compacted lime-fly ash mixtures made with electrically collected fly ashes generally have a higher percentage of solids than mixtures made with mechanically collected fly ashes.

## Stabilization Characteristics of Different Soils

Different types of soil have different characteristics and vary significantly in the way they react with lime. The degree of stabilization of the product, therefore, also varies considerably. Experience with stabilization of different soils with fly ash has provided some information on these variations and is indicative of what can be done with fly ash.

### Clays

Fly ash addition beneficiates lime-clay mixtures to make a stabilized soil that often can compete economically and strengthwise with soils stabilized by other means. Treatment of clays depends mainly on the minerals contained therein (1). Expanding clays containing montmorillonite react readily with lime, immediately losing plasticity and slowly gaining pozzolanic strength. While reduction in plasticity index[7] (usually to below 10) is a major benefit from lime treatment, plasticity reduction depletes the calcium ions, which apparently hinders the reaction with fly ash. Montmorillonites containing sodium as the dominant exchangeable cation presumably would cause the greatest calcium depletion. Moreover, fly ash is sometimes of little benefit with low percentages of lime.

Clays containing mainly illite, chlorite, vermiculite, or kaolinite, while less effective lime robbers and sometimes slightly pozzolanic, still give improved performance when fly ash is added. Best ratios are usually in the range 1:2 to 1:9 lime to fly ash, the total amount of admixture being governed by economics and usage. For clayey soils, the lime should be 5 to 9 percent and fly ash 10 to 25 percent (43).

At early ages, lime-fly ash mixtures, with their reduced plasticity index, are less resistant to freeze-thaw than is the natural clay.

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[7]American Society for Testing and Materials. Standard Method of Test for Plastic Limit and Plasticity Index of Soils. D424-59 in 1968 Book of ASTM Standards: Part II. 1968, pp. 222-224.
Grim, Ralph E. Applied Clay Mineralogy. McGraw-Hill Book Co., 1962, pp. 204-236.

## Silty Soils

Silty soils containing less than 10 or 12 percent clay may be somewhat pozzolanic, depending on mineral composition. In this case stability can be obtained with lime alone or with a low lime to pozzolan ratio, about 1:2. Recommended lime stabilization trial mixes are the same as for clays. Silty soils containing sufficient montmorillonitic clay to coat the grains will not be as pozzolanically active and will benefit from larger additions of fly ash. Before stabilized silty soils gain strength they are highly susceptible to freeze-thaw damage.

Friable loess is most effectively stabilized with cement, although lime or lime-fly ash sometimes may prove satisfactory if the lime and ASTM-quality fly ash is available.

Fly ash addition to lime-gumbotil mixtures has been found beneficial, the stabilized product showing good freeze-thaw resistance and strength.

## Sandy Soils

Sandy soils are too coarse to react well with lime alone, hence addition of a pozzolan such as fly ash is nearly always required. Best ratios are usually about 1 part lime to 5 parts fly ash, and the strength of the stabilized sandy soil increases virtually linearly with percentage total admixture. Sands are not as susceptible to freeze-thaw damage as are silts.

Sandy soils containing 10 to 30 percent combined silt and clay have a better gradation of particle sizes for cementation bonding, thus may stabilize with lime alone, depending mainly on the pozzolanic nature of the minerals in the clay. (Strength and durability are often improved by better gradation.) Usually, however, lime-pozzolan will give best results. Field attempts to blend in clay have met with varying success, depending mainly on intimacy and ease of mixing.

## Coarse Granular Soils

Coarse-graded soils and mixtures with crushed stone possess inherent mechanical stability which may need only slight bonding to meet base course requirements. Well-graded mixes containing binder such as clay or calcium carbonate (caliche) may gain enough strength with addition of as little as 2 to 4 percent lime. If mixes are less well graded or if better cementation properties and flexural strength are needed, requirements can be met by use of fly ash. Unless the binder is pozzolanic, the best lime-fly ash ratio will likely be approximately 1:5.

## Pozzolanic Granular Materials

Pozzolanic materials such as scoria, cinders, chert, or water-cooled slag frequently develop very high strengths when stabilized with lime or lime-fly ash mixtures. Addition of the fly ash or some other pozzolan is often to give a satisfactory gradation for effective cementation of the grains. Flexural

strengths of the stabilized product containing fly ash comparable to those for portland cement concrete have been reported (78). Typical mixes for granular soils contain 3 to 7 percent lime and 10 to 25 percent fly ash.

## Lime Type and Content

The chemical class of lime is an important factor in lime-fly ash stabilization. For instance, dolomitic limes (quicklime and monohydrate) used in normal amounts and cured at ambient temperatures give about a 30-percent stronger product than calcitic limes, except with some kaolinitic soils when strengths are approximately the same (74). (With some fly ashes, however, calcitic lime produces greater 28-day strength than does dolomitic lime.) At low lime contents (3 percent or less), calcitic hydrated lime is more effective than dolomitic monohydrate for stabilizing clayey soils, with or without fly ash. Generally, with standard Proctor compaction, dolomitic lime-fly ash mixtures are denser than calcitic lime-fly ash mixtures. Reportedly, for both calcitic and dolomitic limes, no correlation exists between increased densities and strengths. Although the role of MgO in dolomitic limes is not exactly understood, some believe it may act as a catalyst in the soil-lime reaction. Furthermore, research has shown that magnesium in limes must be in the oxide form to give maximum effectiveness. Optimum molar ratio of calcium to magnesium in dolomitic lime is between 1:1 and 2:1, and most commercial dolomitic monohydrate limes are within these limits. Strength has also been found to be affected by the $SiO_2$ + $R_2O_3$ content and the crystal size of MgO. Limes high in $SiO_2$ + $R_2O_3$ and containing finer MgO particle size produced greater strengths.

Soils, fly ashes, and limes vary widely in physical and chemical characteristics and the required amount of each is governed by economy and the desired strength for the stabilized soil (78). Lime is 5 to 10 times more costly than fly ash, thus favoring the use of maximum percentages of fly ash if readily available (43). Since economy is of prime importance and the lime-fly ash ratio is not very critical, selection of the proper proportions can best be done by eliminating all uneconomical trial mixes. No optimum ratio of lime and fly ash has been found, however, that satisfactorily stabilizes all soils.

## Moisture

Optimum moisture content for compaction of soil-lime and soil-lime-fly ash mixtures varies, depending on percentage lime and percentage fly ash. Moisture content is important because it must be near the optimum to obtain maximum strength (39, 42) in the hardened mixture. Moisture-density curves of montmorillonitic clay soils stabilized with lime are affected by the flocculating effects of lime, and sometimes the curves do not show a maximum density (43). Optimum moisture content for maximum strength of lime-fly ash mixtures is generally slightly below the optimum for maximum bulk density and is apparently a function of carbon content and fineness of the fly ash (79). A moisture-density curve (ASTM Designation D698-57T) may be run for each trial mix, or moisture contents can be estimated by interpolation between two or three selected mix-test values (78). For example, in figure 6 (78), the corners of

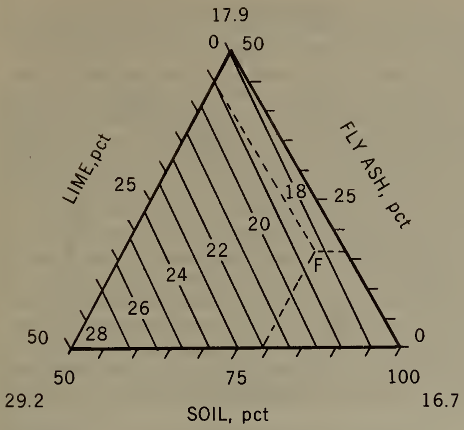


FIGURE 6. - Optimum Moisture-Content Interpolation by Triangular Chart.

the triangle represent mixes of 50:50 soil-lime, 50:50 soil-fly ash, and 100 percent soil. The optimum moisture concentrations determined in the laboratory are 29.2, 17.9, and 16.7 percent, respectively. The intermediate unit percentages, 18.0, 19.0, 20.0, etc., are scaled off on the appropriate sides of the triangle and connected by straight lines. The approximate optimum moisture content of any intermediate mix composition may then be read directly from the chart. Different plots are required for different kinds of soil, lime, or fly ash.

The mix finally selected for field use is put through the standard moisture-density test to more accurately apprise the moisture requirements and to measure the density expected in the field. Results from this test are also used for molding specimens for durability tests.

If little time is available for testing, optimum moisture contents of trial mixes can be estimated by texture or "feel." The accuracy of this method depends on the experience test personnel have had with the types of soils involved.

The above outline applies equally well for compaction to standard Proctor density or to a higher density employing greater compactive effort and a lower optimum moisture content. Higher compaction greatly improves pozzolanic cementation because of better grain contact (38).

## Stabilized Soil Specifications

In climates where the ground seldom freezes, 7- or 28-day strengths are reliable criteria for selection of a mix. Strengths are correlated with field-performance records to establish safe minimum requirements. The Texas Highway Department method utilizes Mohr envelopes obtained from triaxial testing. Stabilized soil is either tested triaxially or the soil may be approved for use if the unconfined compressive strength exceeds 100 psi. Details of the method are published in Soil Testing Procedures, Texas Highway Department, 1952.

The California bearing ratio (CBR) is widely used to evaluate flexible base courses and as a basis for subbase, base, and surface-course thickness design. Ordinarily a minimum CBR of 80 is specified for materials directly underlying bituminous surfacing. Lower CBR's are allowable at lower depths where wheel-load stresses are more widely distributed.

Unconfined compressive strength is widely used for mix evaluation, but minimum criteria are not yet known to have been established. Criteria should take into account the fact that satisfactorily stabilized granular soils are weaker in the test than in a road where shearing strength is increased by the lateral confinement. Cohesive soils, however, gain relatively little strength from confinement, and the unconfined compression test is a more direct evaluation. The British Road Research Laboratory suggests a minimum 7-day strength value of 250 psi for cement-stabilized soils, and up to 400 to 500 psi for cement-stabilized clays or stabilized soils subjected to severe climatic conditions. Recent data from the Portland Cement Association (PCA) indicate that soil cement having an unconfined compressive strength of 300 to 800 psi after 7 days will pass the durability tests. Field and laboratory tests of soil-lime-fly ash at Detroit, Mich., showed that an unconfined compressive strength of about 500 psi is necessary to prevent damage from repeated cycles of freezing and thawing. Ordinarily this strength is not attained before at least 28 curing days. Mixes giving 28-day strengths of 500 psi will usually give 7-day strengths of about 250 to 300 psi. Laboratories using accelerated (140° F) 7-day curing to predict 28-day strengths sometimes specify a minimum of 500 psi for light loads.

In freezing climates, durability (strength loss) is the major requirement. Rigorous standards have been set up by the PCA for soil cement (ASTM Designation D560-57). Details are given in the PCA's Soil-Cement Laboratory Handbook, 1959. Soil-lime and soil-lime-fly ash products seldom pass these tests unless curing is prolonged or cementation is speeded by chemical accelerators.

An alternate method for measuring durability is to measure the decrease in unconfined compressive strength after a number of freeze-thaw cycles. Durability ratio, as defined by the British Road Research Laboratory, is the strength after weathering divided by the strength obtained by curing the same length of time. A ratio of 80 percent after 14 freezing-thaw cycles is regarded as satisfactory.

Durability is also determinable from change in pulse velocity measurements. A linear relationship exists between the pulse velocity in low-strength concretes and the logarithm of compressive strength. Little such correlative work has been done with soil-lime or soil-lime-fly ash. However, a slight decrease or no change in velocity during successive cycles of freeze-thaw is an indication of good durability.

## Mix Selection

Selection of the proper mix has been the objective of research and experimentation. One such study by Woods, Berry, and Goetz gives considerable information on this subject (78). According to the procedures given, a maximum allowable lime percentage is first selected which is economically competitive with other types of construction, such as soil cement, crushed stone, etc. As a hypothetical example, this is plotted as point A in figure 7. Next, the cost of handling an additional material (for example, fly ash) is estimated and expressed as its equivalent in percentage lime. This is subtracted from A to give point B. Starting at point B, an equal-cost line is drawn with a

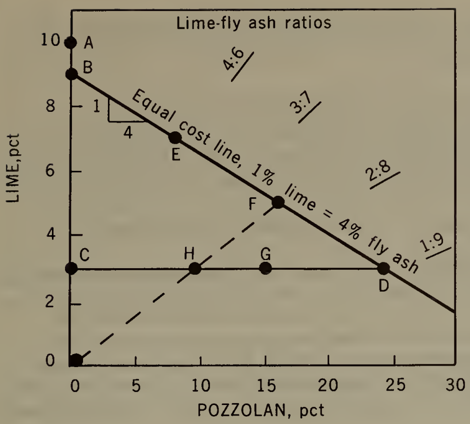


FIGURE 7. - Soil-Lime-Pozzolan Mix Design by Equal-Cost-Line Method.

negative slope equal to the cost of fly ash divided by the cost of lime, both on a dry, delivered, per-ton basis. (In this method, mix percentages must be expressed on a total-dry-mix basis.) Trial mixes are then selected from the area below this line, since proportions above the line are uneconomical. A second limitation which can be imposed is to require a minimum of 3 percent lime, since, in field construction, lower lime contents may lead to lean areas as a result of imperfect mixing. This limit is represented by line CD. A lower minimum content may be permissible if lime is applied in a slurry.

Selection of trial mixes from within triangle BCD is partly a matter of judgment. If maximum strength is desired, equal-cost points are selected at A and along line BD. For example, in figure 7, one might select 10 percent lime, 90 percent soil (point A), then 7 percent lime plus 8 percent pozzolan, abbreviated as 85:7:8, soil:lime:pozzolan (point E), then 79:5:16 (point F), and 73:3:24 (point D). Intermediate points can be filled in if desired. Ordinarily one of these mixes will give the highest strength and durability. If the resulting strength is excessive for the proposed use, costs can be cut by using less pozzolan or less lime or less of both. For example, if F and D are found to be about equally overdesigned, the more economical ratio 82:3:15 (point G) could be tried. Or if F is the best mix, trials could be made at points intermediate to F and H, thus maintaining the same lime-pozzolan ratio. If none of the trial mixes gives satisfactory strength and durability, the lime or pozzolan or soil type may be at fault, or chemical accelerators can be tried.

Under some circumstances, stabilization with lime alone is most satisfactory and economical. For example, if economy dictates a lower equal cost line, thus limiting the cost triangle to low percentages of pozzolan, lime stabilization should be given first consideration (78). Trial mixes may be prepared with different percentages of lime. Often, strengths are increased relatively little by additions beyond a certain percentage lime, the optimum being in the range 2 to 10 percent.

Appendix B of this report gives a procedure for determining the strength durability of stabilized soils specimens (78).

## Base Course Construction

Considerable field experience has been gained and much knowledge obtained from the laboratory on the use of fly ash with lime and aggregates for base

course construction. In these pavements, the main load-carrying portion consists of the hardened base of lime-pozzolan-aggregate mixture; a wearing surface is placed over the pozzolanic layer.

Comprehensive studies of the engineering properties of lime-fly ash-aggregate mixtures (2, 9, 29) and experience have shown that these mixtures can be easily handled with normal construction equipment. The constituents can be blended in a dry or semidry state and placed and compacted at the optimum moisture content, eliminating the costly forming process necessary with plastic mixtures. Such mixtures have proven to be economical and durable.

Research at the University of Illinois, however, has provided much valuable information of value for design purposes (2). Test track studies were conducted that permitted comparison of fly ash and crushed stone pavements; basis engineering properties of the materials were determined to assist analytical studies of pavement behavior under load; results from the test track were correlated, via theoretical analyses, to other conditions. From this was developed a thickness design procedure for fly ash pavements that was verified from the test track results.

Subject to the test conditions, several tentative conclusions were made in this study (2) regarding behavior and potential performance of fly ash pavements:

1. Fly ash-lime-aggregate mixtures develop strength over an extended period of time and at rates that are a function of climate conditions. Loading stresses do not influence the total strength developed, but strength developed during loading effectively increases pavement strength.

2. The beam flexure test is the most effective way to evaluate the flexural strength of the fly ash material, but flexural strength of the material can be estimated from the compressive strength.

3. The modulus of elasticity of the fly ash material increases with age. The most effective method of measuring the modulus of elasticity of the fly ash material for evaluating pavement behavior is in flexure. The flexural modulus of elasticity remains reasonably linear for stresses up to approximately one-half the failure stress but decreases at an increasing rate for stresses in excess of one-half the failure stress.

4. Deflection characteristics of fly ash pavements under static loads up to one-half the failure load can be estimated with reasonable accuracy from elastic theory by using the modulus of elasticity of the fly ash material in flexure and results from plate-bearing tests for subgrade support. As the load is increased beyond one-half the failure load, the deflection increases faster than the increase in load. The deflection rate increase for loads greater than one-half the failure load is due primarily to the reduced modulus of elasticity of the fly ash material as the stress approaches the failure condition.

The deflection of the pavements under moving loads is somewhat less than under the static loads; the decrease is probably due to the visco-elastic

nature of the subgrade, as the modulus of elasticity of the fly ash material was not changed significantly with changes in the rate of loading.

5. The load-carrying capacity of fly ash pavements under static loads can be estimated by ultimate theory proposed by Meyerhof for plain concrete slabs. The load-carrying capacity of the pavements is significantly greater than the maximum load predicted by Westergaard's theory for elastic slabs, using the modulus of rupture as the yield stress for the fly ash material.

6. Hardened fly ash pavements, because of their slab action, distribute the stress over a large area of the subgrade. The stress distribution over a large area results in low subgrade stresses and relatively low deflection values for the pavement.

7. The load-carrying capacity of cured and hardened fly ash pavements is not greatly affected by the supporting value of the subgrade. Thus, Meyerhof's equations can be used to estimate the failure load of fly ash pavements under moving loads as well as static loads.

8. It was not possible to predict the failure of the fly ash pavements under repeated loads using Westergaard's elastic slab theory and the fatigue properties of the material. A good correlation was obtained between the predicted and actual number of load applications to failure, using Meyerhof's theory for the failure load and the fatigue properties of the material.

9. Fly ash-lime-aggregate pavements will give excellent performance under repeated load applications provided the pavement is strong enough so that the maximum load will not cause structural damage to the pavement. If the pavements are overloaded to the extent that structural damage takes place, the serviceability-rating of the pavement may decrease rapidly under repeated load applications of the same magnitude.

10. Performance of underdesigned fly ash pavements can be increased either by increased strength of the fly ash-lime-aggregate material or by increasing the thickness of the pavement. Because of the strength development of these materials with time and the increased modulus of elasticity, greater loads can be placed on the more mature pavements without damage to the pavement.

11. Loads applied near the edge of the pavement slab are much more critical than those placed a significant distance from the edges.

12. Properly designed fly ash-lime-aggregate materials have the potential of making excellent paving materials. Results from both the test program and from existing pavements indicate that properly designed pavements using high-quality fly ash will give outstanding performance for pavement usage under normal conditions.

## MINERAL FILLER

Mineral filler represents only a small proportion of an asphalt mix, but the filler is important to the performance of the finished surface. For example, pavements should resist densification under heavy wheel loads and high

tire-contact pressures (8). Densification resistance can be increased by reducing the asphalt content (dry pavement) but this gives a product with a relatively short life. Increasing the asphalt content, on the other hand, can lead to stability loss, with bleeding and flushing of the asphalt under heavy loads. The best compromise is a product that contains the maximum amount of asphalt yet retains satisfactory stability. Mineral filler content is believed to play an important role in this balance.

Although fly ash has been used for years as a mineral filler in asphaltic road surfaces, little information has been published on the subject. As early as 1931, it was known that a satisfactory asphalt surface could be made by substituting fly ash for limestone dust as a mineral filler (23). Advantages of fly ash as a mineral filler include lower cost, proper size gradation (without processing), and superior resistance to water in dense-type bituminous concrete.

Resistance to water of the asphalt is an important criteria of the product. Table 17 gives results of immersion-compression tests, in which the fillers are rated on resistance of the compacted mixtures to loss of strength. Fly ash was found equal to or superior to the other fillers (19). In these tests, it was determined that higher immersion times were not required for a valid comparison of the respective quality of the products. Chemical analyses of the traprock dust and fly ash are given in table 18 for comparative purposes. Strength retention for eight fly ashes ranged from 85 to 100 percent--all above the 75-percent figure considered the critical minimum. Carpenter also confirmed during these tests that quality filler can compensate slightly inferior coarse aggregates vis-a-vis strength of the product.

TABLE 17. - Typical strength retention values of asphalts made with traprock dust, limestone dust, or fly ash[1]

| | Strength retained, pct |
|---|---|
| Traprock dust: | |
| Massachusetts | 90 |
| New Jersey: | |
| Sample 1 | 83 |
| Sample 2 | 86 |
| Virginia | 93 |
| Limestone dust | 87 |
| Fly ash: | |
| Illinois | 97 |
| New Jersey: | |
| Sample 1 | 96 |
| Sample 2 | 91 |
| Sample 3 | 91 |

[1]4-day immersion in water at 120° F; asphalt content 5-1/2 parts/100 parts coarse aggregate; filler utilized as-received.

TABLE 18. - Analyses of fly ash and traprock dust, pct

| | LOI[1] | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_2$ | $Na_2O$ | $K_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| Traprock dust: | | | | | | | | | |
| Massachusetts... | 3 | 50 | 14 | 14 | 9 | 6 | - | 3 | 1 |
| New Jersey: | | | | | | | | | |
| Sample 1...... } Sample 2...... } | 2 | 51 | 15 | 11 | 10 | 8 | <1 | 2 | <1 |
| Virginia........ | - | - | - | - | - | - | - | - | - |
| Fly ash: | | | | | | | | | |
| Illinois........ | 3 | 45 | 20 | 20 | 6 | 1 | 2 | 1 | 2 |
| New Jersey: | | | | | | | | | |
| Sample 1...... | 4 | 48 | 15 | 28 | 1 | 1 | <1 | <1 | 2 |
| Sample 2...... | 2 | 42 | 24 | 22 | 6 | 1 | 1 | <1 | 1 |
| Sample 3...... | 5 | 43 | 30 | 16 | 4 | <1 | <1 | <1 | 1 |

[1]Loss on ignition; 1,830° F. Includes free carbon. Most of loss from fly ash likely derived from free carbon.

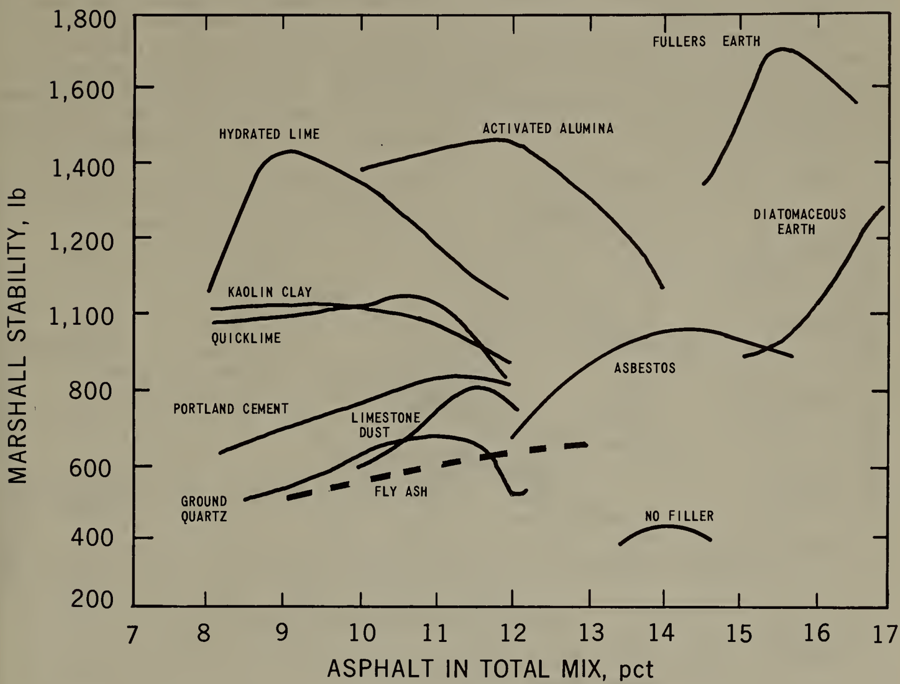


FIGURE 8. - Effect of Filler Types on Stability of Sheet Asphalt.

Resistance to flow is another important property and standard of comparison. The usual measure of this is Marshall stability, which is the resistance to plastic flow of cylindrical specimens of bituminous paving mixture loaded on a lateral surface (6). Figures 8, 9, 10, and 11 compare fillers on the basis of the Marshall stability of the resulting products (8). In this comparison fly ash rated among the lowest in Marshall stability, but information provided by the study reportedly may not be conclusive. Field testing is stated to be the true criteria of filler utility, it being noted that limestone dust rated poorly in the tests yet is often specified as a mineral filler for asphalt.

More than a dozen States representative of all regions of the United States approve of fly ash as a mineral filler in asphalt paving and highway construction. Typical of this acceptance is the standard specification for construction of roads and bridges in the State of Michigan (44). According to Michigan specifications, the fly ash must be collected by electrostatic precipitators and the free carbon must not exceed 12 weight-percent as measured by the loss on ignition. Fly ash from each source must be tested and approved and perform satisfactorily in laboratory mix stability tests and field construction applications. As specified for other mineral fillers, the fly ash must be dry and free from lumps and objectionable materials. All of the fly ash must pass through a No. 30 sieve and at least 75 weight-percent must pass through a No. 200 sieve, of which 15 to 60 percent must be less than 10 microns (0.010 mm) in diameter.

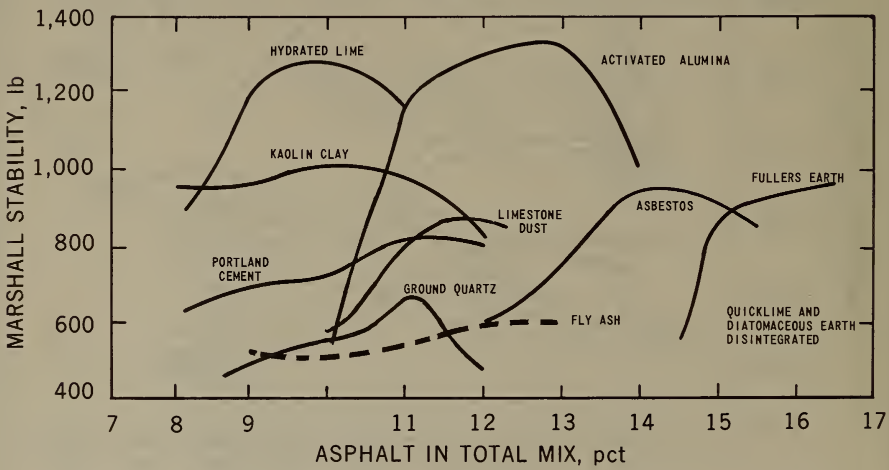


FIGURE 9. - Effect of Filler Types on Stability of Sheet Asphalt; Regular Mixing, Tested After 18-Hour Immersion at 140° F.

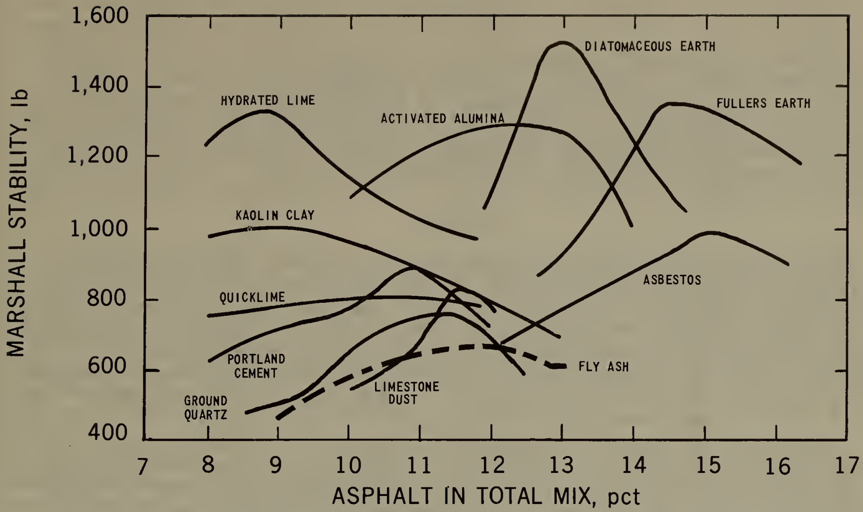


FIGURE 10. - Effect of Filler Types on Stability of Sheet Asphalt; Premixed, Regular Testing.

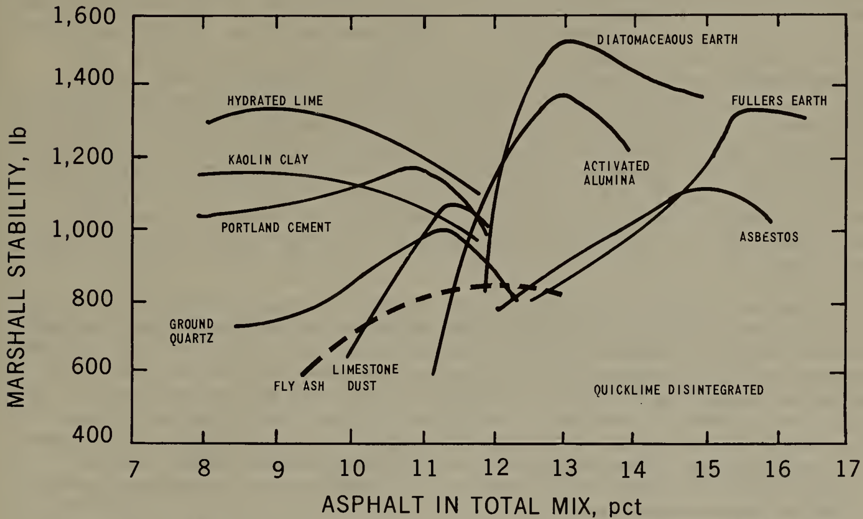


FIGURE 11. - Effect of Filler Types on Stability of Sheet Asphalt; Premixed, Tested After 18-Hour Immersion at 140° F.

## AGRICULTURE

Fly ash utilization in agriculture, as a subject, does not fall readily into separate subject categories. Certain fundamentals are common to all potential applications, and any division of the topic is somewhat arbitrary and subject to overlapping of technology. However, three main categories appear to encompass most of the information available--farming, surface-mine spoils reclamation, and turf-soil beneficiation.

### Farming

Restoration and reclamation of ash disposal sites to make them suitable for agriculture purposes presents two distinct problems and have been given separate consideration by researchers. Land restoration is effected by covering fly ash piles (after leveling) with a foot or more of topsoil, then planting and maintaining it like ordinary farmland, with no further special treatment. This is relatively easy. Reclamation, on the other hand, involves growing crops in the fly ash itself and is considerably more difficult.

Researchers at Leeds and Birmingham Universities in Great Britain, studying the problems of reclamation, found that some coal constituents are changed during combustion so as to make them more soluble or available, while others are unaffected (7). Of seventeen most commonly occurring elements in ash, boron was the principal offender in restricting the growth of some plants. Boron availability to plants may be only 1 to 2 parts per million in soil, but it may be 15 times as much in fly ash. Since removal of the excess boron by chemical treatment was not practical, a search was begun for plants that tolerate ash conditions. Greenhouse and field experiments showed white sweet clover to thrive under the most toxic conditions, followed by white wild clover, red clover, and lucerne. Grasses, particularly rye grasses, were tolerant. Of the arable crops, those of the beet and cabbage families thrived best. Sugar beet, fodder beet, and mangels benefited from the boron content, provided it was not too high. Rye was the only cereal that was really tolerant of ash conditions; at one site, fields were superior to those obtained from soil alone. Many plants, however, were quite intolerant of ash conditions. Oats, barley, peas, beans, and potatoes were among the commoner crops most affected.

In contrast to the results with fly ash in Britain, studies in the United States have shown that only aluminum and manganese may be available in quantities high enough to produce signs of toxicity in plants. In the early natural succession of native vegetation invading fly ash deposits, an absence of the commoner weeds was noted by U.S. researchers (26), and they attribute this to the aluminum content of the ash. They also observed that aluminum in acid soils inhibited the growth of 21 common grassland weeds. However, the common weed genus Atriplex (Chenopodiaceae), a widespread representative of the goosefoot family, is apparently immune to the toxic effect of aluminum under the circumstances mentioned.

Others studied the possible benefits fly ash might bring to crops while conceivably inhibiting or excluding the growth of certain weed plants (57).

Barley (Hordeum) and spinach (Spinacia oleracea), grown on fly ash, accumulated excessive amounts of aluminum and manganese in their leaf tissue and exhibited signs of toxicity. When fertilizers were added to the substrate, dry weight yields of plant tissue increased. The aluminum and manganese content of the weed, Atriplex hastata var. deltoidea, was equally high when compared with that of barley and spinach but showed no signs of toxicity. In barley, the aluminum of the fly ash substrates induced evidences of phosphorus deficiency but this effect was not shown by the other test plants. A wide variety of indicator plants grown on fly ash confirmed the existence of aluminum and manganese toxicity.

There is general agreement in both the United States and Britain that the most tolerant plants are the grasses and legumes, and therefore these make excellent pioneer crops on ash. Such crops can initiate a fertile condition which can be enhanced by further cropping. In this way there is a buildup of colloidal organic matter in the ash from plant remains, and normal soil populations, such as earthworms, gradually establish themselves. A few years of hay farming, coupled with grazing by animals, greatly improves the fertility and makes an extended range of crops possible in minimum time.

It has also been observed that plants grow more readily on old ash than on freshly dumped ash, apparently because leaching has removed much of the toxic material. If immediate reclamation of a toxic ash site is desired or required, it is recommended that the surface be mixed with a bulky ameliorant such as soil, sewage sludge, subsoil, or shale. The acidity of certain shales and subsoils reduces the alkalinity of the ash, and soils and subsoils provide the fine colloidal particles which are lacking in ash.

Agronomy Researchers at Virginia Polytechnic University, Blacksburg, Va., in laboratory and greenhouse experiments have evaluated the effect of fly ash application on the power of agricultural soils to supply boron (13), molybdenum, potassium, and zinc.[8] Fly ash used in these experiments was selected from a group of samples obtained from 15 powerplants located in nine States. Each of three samples of fly ash applied to Tatum silt loam was found to increase the plant available B content of the soil. The B in the fly ash samples was sufficiently available to overcome the decrease in B availability resulting from the increase in soil pH due to application of the byproduct. The two samples of fly ash applied to Groseclose silt loam increased the yield of alfalfa (Medicago sativa L.) grown on the soil. The increase in yield was attributed to the increase in both soluble molybdenum (Mo) and soil pH resulting from application of the fly ash. Apparently, aluminum (Al) or manganese (Mn) toxicity of alfalfa was alleviated by increasing the pH of the Groseclose soil. Four of nine samples of fly ash applied to a Davidson clay loam increased the plant available potassium (K) content of the soil. The potassium (K) in these sources of fly ash was less available than the potassium (K) in potassium chloride (KCl). Zinc deficiency of corn plants grown on Tatum and Frederick silt loams was corrected by application of a fly ash sample, which decreased the pH of the soils. The inverse relationship between zinc (Zn)

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[8] Personal communication from David C. Martens, associate professor of agronomy, Virginia Polytechnic Institute, Blacksburg, Va.

availability and soil pH appeared to result from greater dissociation of zinc (Zn) from zinc silicate compounds as the pH of soil decreased.

## Surface-Mine Spoils Reclamation

Research has demonstrated the technical feasibility of reclaiming surface-mine spoil with fly ash (18, 24). Engle and Capp, for instance, report that certain properties of fly ash make it attractive as an additive and conditioner for reclaiming acid surface mined areas. In addition to availability in large quantities, some fly ashes have a high pH (to neutralize acid spoils), a higher content of some macroplant and most microplant nutrients than many soils, better moisture retention than many soils, and a diluting effect when mixed with heavy textured soils. Table 19 shows some of the more common elements found in powerplant fly ash. Percentages of elements listed are about the same or somewhat higher than those found in many natural soils. Most fly ash sources, however, contain very little phosphorus and generally are devoid of nitrogen. These elements must be added through fertilization if vegetation is to be established on fly ash.

TABLE 19. - Elements in fly ash

| Element | Percent | Approximate amount/600 tons ash, lb |
|---|---|---|
| Calcium...... | 1.00 | 12,000 |
| Magnesium.... | .36 | 4,000 |
| Potassium.... | 1.74 | 21,000 |
| Phosphorus... | .13 | 1,600 |
| Cobalt....... | .01 | 60 |
| Molybdenum... | .01 | 80 |
| Boron........ | .01 | 100 |
| Manganese.... | .02 | 250 |
| Aluminum..... | 14.01 | 170,000 |
| Iron......... | 9.94 | 120,000 |

The pH of the fly ash-treated spoil bank plots is raised from an initial value of 3.5 to about 5.2. At pH values above 5.0 little aluminum and manganese, which are the principal toxic elements in spoil, are in solution. There is some question as to whether this favorable pH will remain or whether it will drop below 5.0 and then the solution of toxic elements ultimately would kill the vegetation. The former contention is considered most likely.

Optical examination of the fly ash in the study discussed above reveals that it is composed mainly of glassy spheres, 0.02 to 2.0 mm in diameter, derived from shales that were in the coal. Combustion had fused a large portion of the elements in the coal into these spheres. In a 600-ton/acre application of fly ash of the composition shown in table 19, the quantity of potential liming material added (shown as elemental calcium and magnesium) is considerable. Being fused into glass spheres, some of this liming material is released slowly and should neutralize the spoil for many years.

Initial physical and chemical properties of the spoil at the site were: pH--3.5; nitrogen, phosphorus, potassium, and organic matter--very low; cation exchange capacity (C.E.C.)--12 milliequivalents per 100 grams; clay, silt, and sand--21, 23, and 56 percent, respectively. The spoils contained many coarse fragments, ranging in size from pebbles up to boulders weighing several hundred pounds.

Observations in the laboratory and in the field strengthen the technical feasibility of using fly ash on strip soil. Because of the large amounts of siltlike fly ash that are required, the soil texture is improved. For example, the textural classification of this soil was shifted from sandy clay loam to either silt loam or loam, depending upon specific areas where the sample was obtained.

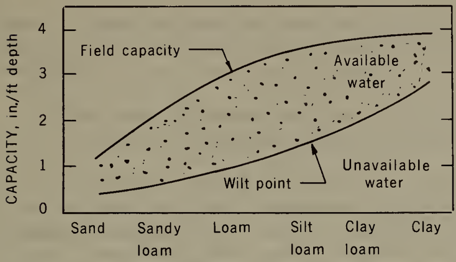


FIGURE 12. - Typical Water-Holding Capacities of Different Textured Soils.

A great advantage to the change in texture is that soils with the largest available water-holding capacity for plant growth are characterized by being high in silt. Figure 12, which compares the wilt point and field capacity of different textured soils, further illustrates this point (46). The capacity of the soil to hold water is related to surface area, pore-space volume, and continuity of the pore space. Water-holding capacity is therefore related to structure as well as to texture. It can be seen in figure 12 that fine-textured soils have the maximum total water-holding capacity, but that maximum available water is held in medium-textured soils. Research has shown that available water in many soils is closely correlated with the content of silt and very fine sand.

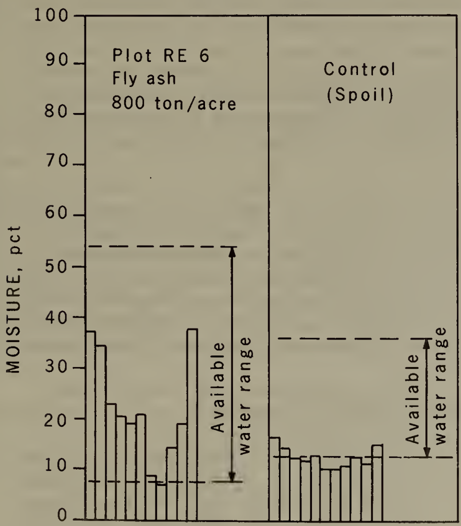


FIGURE 13. - Moisture Availability of Fly Ash-Modified Soil.

Further evidence of the beneficial effect that the use of fly ash has on the water capacity of the spoil and the availability of this moisture is indicated by figure 13. This figure gives quantitative moisture values for the undisturbed control plot and a plot treated with 800 tons/acre of fly ash at a strip site. Field capacity and wilt point

values for these plots, indicated at the side of the figure, show how the available water range corresponds to the actual moisture content under field conditions. Heavy spring rains built up a significant reservoir of moisture in the fly ash-treated plot and continued to be available even during the summer dry period, as the bar graph bears out. On the other hand, the control plot retained little moisture from the spring rains and during the dry period moisture was not in the available range for plants for several weeks. Since the actual moisture content of the control spoil remains at or near the wilt point value, most of the water that fell on this area as rain probably ran off and was not absorbed.

Bulk density determinations of soil samples from the control plot and the fly ash-treated plot were 1.56 g/cc and 0.92 g/cc, respectively. Assuming an average particle density of 2.65 g/cc, the percent total pore space in these two samples was calculated at 41.1 and 65.3, respectively. The increased soil porosity results in increased air capacity, water availability, and infiltration, while at the same time controlling high runoff and soil erosion.

After the sites were treated with fly ash, all the plots, including the controls, were fertilized with a 10-10-10 analysis granular fertilizer at the rate of 1,000 lb/acre. The plots were then seeded with grass or grass-legume mixtures, principally Kentucky 31 fescue, orchard grass, rye grass, red top, bird's-foot trefoil, and alfalfa. Dry matter (hay) yields are indicative of the beneficial effects of fly ash treatment. At one site--an acid spoil associated with the mining of the Sewickley coal seam--an average yield of 1.09 tons/acre was obtained from the fly ash-treated areas; a limestone-treated control plot at the same site produced only 0.54 ton/acre. At a second site, representing an acid spoil associated with the mining of the Bakerstown coal seam, an average yield of 1.39 tons/acre was obtained from the fly ash-treated areas. (Because of the very poor survival after germination, unneutralized control plots at both sites gave no yields.) These average yields compare favorably with the average hay yield for 1967-68 of about 1-1/2 tons/acre for West Virginia (75).

Although reclamation of strip spoil with fly ash appears technically feasible, practical application and widespread acceptance depend on a number of other considerations. Economic justification will be a major factor, and esthetics and strip mining laws will also play important roles. Surface mining doubtless will continue to be a major factor in recovering minerals vital to the Nation's economy, hence there is continued incentive to evolve better reclamation techniques and develop methods of recovering minerals with minimum damage to surface areas and streams.

## Soil Modification With Sintered Fly Ash

Lightweight aggregate, produced by pelletizing and sintering raw fly ash (16-17; see the lightweight aggregate section of this report), has characteristics similar to some materials that are used to modify soils of turf grass areas (18). Materials commonly used for this purpose include peat, lignified wood, calcined clay, calcined diatomite, expanded shales, sewage sludge, animal manures, sand, and sawdust. Beneficial aspects from the use of various

soil modifiers include increased aggregation, water infiltration and percolation, reduced surface runoff, improved hydraulic conductivity, and decreased soil compaction (28, 61-62, 66).

Limited amounts of calcium, phosphorus, magnesium, and iron have been found in raw fly ash (12), but it is deficient in the macronutrient nitrogen and frequently also deficient in potassium (13, 27). However, it contains essential micronutrients, and many of them are in soluble form (20), some in concentrations high enough to cause phytotoxicity. Boron, as stated, is particularly abundant in raw fly ash (30, 32). Phytotoxic concentrations of manganese and the nonessential element aluminum (32, 57) are also present at times. Sintering appears to convert many of the potentially phytotoxic elements in raw fly ash into more tightly bonded and essentially unavailable compounds.

Field and laboratory tests to evaluate sintered fly ash for turf soil modification provide some information on the subject (51-52). Raw fly ash was pelletized on a revolving disk, sintered on a traveling grate, and crushed to break up clinkers, then graded into required sizes and transported to the field site. Sod at the site (primarily Poa pratensis L., Festuca rubra L., and Trifolim repens L.) was cut to a depth of 1-1/4 inches and rolled to the edge of each respective plot. After which the exposed soil was rotary-tilled to a depth of 15 cm. Sintered ash was added in amounts equal to 14, 25, and 33 vol pct and mixed thoroughly to the 15-cm depth. The plots were then smoothed and the original sod was replaced. For comparison, nearby plots were processed the same way but without sintered fly ash added (check treatments = Ck); still other plots were left undisturbed entirely (undisturbed control = Uc).

Moisture content of the soil under high-moisture conditions at the 0- to 7.5-cm depth was essentially the same for all the plots (fig. 14) but at the 7.5- to 15-cm depth was slightly higher for the fly ash modified soils. Under periods of low-moisture conditions (high-moisture stress), the moisture content of the fly ash soil at the 0- to 7.5-cm depth decreased. Measured moisture concentrations at the 7.5- to 15-cm depth for the undistrubed control (Uc) and check (Ck) treatments was 11 and 10 percent, respectively; modified soil plots containing 14, 24, and 33 vol pct fly ash contained 7.6, 8.2, and 10.8 percent moisture, respectively (fig. 14). Sintered fly ash, therefore, appeared to absorb moisture rather rapidly and the water thus absorbed was retained less vigorously or released more easily during dry periods. Also, the water in the 0- to 7.5-cm root zone apparently was readily released and moved downward into the 7.5- to 15-cm root zone.

Intake rates and accumulated intake of the soil-sintered fly ash mixtures appeared to be much higher than those of the undisturbed control (51).

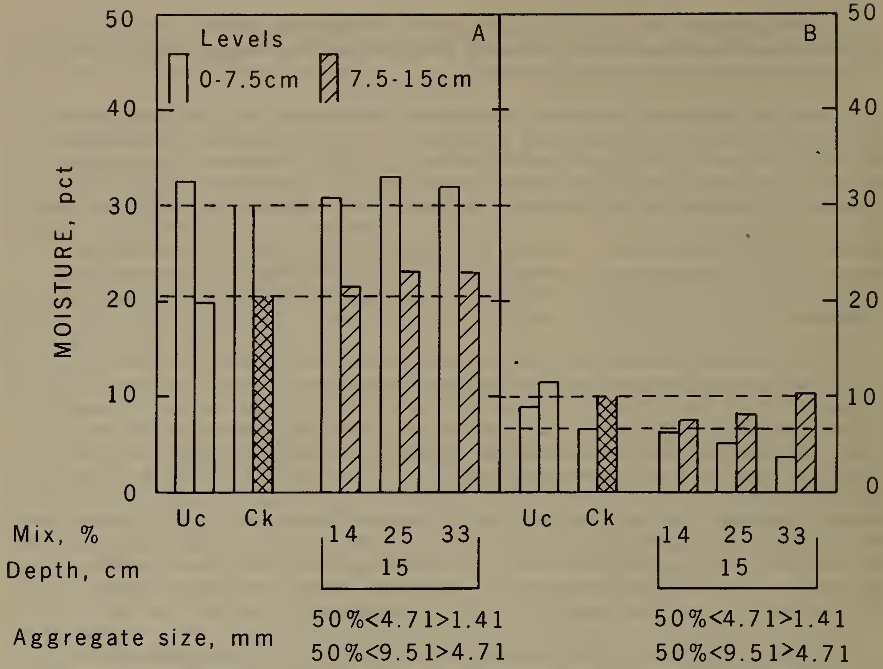


FIGURE 14. - Effect of Sintered Fly Ash Treatment on Moisture Content of Soils at A, High-Moisture Conditions, and B, Low-Moisture Conditions.

Intake rates determined by Kohnke's classification (33) were as follows:

A. Moderately slow--undisturbed control:

14 vol pct mixtures with >1.41 mm <4.71 mm and >4.71 mm <9.51 mm.

B. Moderate--14 vol pct mixture with 50 percent >1.41 mm <4.71 mm and 50 percent >4.71 mm <9.51 mm;
33 percent vol pct mixture with >1.41 mm <4.71 mm.

C. Moderately rapid--33 vol pct mixture with >4.71 <9.51 mm.

D. Rapid--33 vol pct mixture with 50 percent >1.41 mm <4.71 mm and 50 percent >4.71 mm <9.51 mm.

Accumulated intake tended to increase with the increase in vol pct of sintered fly ash added (51). In all cases, average accumulated intakes and intake rates, listed in increasing order of infiltration, were as follows:

1. Undisturbed control (unmodified).
2. 14 vol pct, >1.41 mm <4.71 mm.
3. 14 vol pct, >4.71 mm <9.51 mm.
4. 14 vol pct, 50 percent >1.41 mm <4.71 mm;
   50 percent >4.71 mm <9.51 mm.
5. 33 vol pct, >1.41 mm <4.71 mm.
6. 33 vol pct, >4.71 mm <9.51 mm.
7. 33 vol pct, 50 percent >1.41 mm <4.71 mm;
   50 percent >4.71 mm <9.51 mm.

Results of the field experiments indicated that sintered fly ash is potentially valuable as a soil modifier, particularly to assist drainage and water infiltration on heavily used turf areas. Both intake rates and accumulated intakes were increased by addition of the sintered fly ash, and infiltration from the surface to the root zone was much improved. Sintering involves very high temperatures, hence the product is relatively inert and not likely to cause adverse effects. Sintering also appears to inhibit the release of excessive amounts of certain micronutrients that could be phytotoxic.

## BRICK MANUFACTURE

The physical and chemical characteristics of most fly ashes make them adaptable as a raw material for brick manufacture. Fly ash consists mainly of spherical particles that are mainly finely divided ceramic glass (melting at 2,500° to 2,700° F), with minor inclusions of crystalline material (49). Fly ashes are usually high in iron which is in the glass in the form of iron stain. Although many types of fly ashes may be used for making brick and ceramic products, the most useful and preferred are those collected by precipitation and with low-carbon and soluble salt contents.

Four types of brick consisting mainly of fly ash or fly ash mixed with another material are of predominant importance. These bricks are catalogued as fly ash, fly ash-clay, fly ash-slag, and fly ash-sand.

### Fly Ash Brick

Bricks have been manufactured on a pilot plant scale from 74 percent fine fly ash and 23 percent coarse bottom ash (slag) mixed with 3 percent sodium silicate (dry weights) binder (58, 60). A 3 to 1 proportion of fine ash to slag is approximately the same as produced by a powerplant. Although the volume of silicate is small, it represents three-quarters of the cost of raw materials. Output of the pilot plant was 1,000 to 1,200 bricks/day and was limited only by the capacity of the periodic firing kilns.

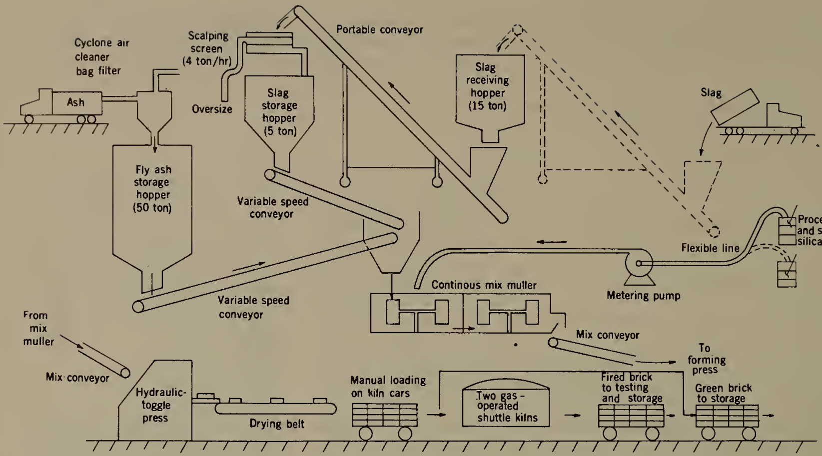


FIGURE 15. - Flow Diagram of Fly Ash-Brick Pilot Plant.

## Process

Figure 15 is a schematic flow diagram of the equipment layout and the flow of raw materials.

Fly ash for the plant is stored in a 50-ton hopper fed with a 5-in.-diameter pneumatic-transport line; the coarse ash is stored in a hopper after passing through a 4-ton/hr scalping screen. Oversize rejects from the screens are discarded or recycled through a secondary crusher and returned to the slag hopper.

Fly ash, slag, and sodium silicate are mixed with water in a 13-ton/hr continuous mix-muller where the silicate bonds physically with the fly ash. The mixture is then rapidly conveyed to a 750-ton hydraulic toggle press that produces cored brick, blocks, and other shapes by means of simple die changes. Cored bricks are produced at up to 40/min.

Green bricks from the press are fired in two gas-operated shuttle kilns, each having a capacity of 500 bricks. The firing cycle depends on the raw materials used. Bricks made from bituminous coal fly ash, for example, may be heated at 250° F for 1 to 2 hours to eliminate moisture, raised by 200° F/hr to 1,000° F and held for 2 to 5 hours, then increased at 175° F/hr to 2,000° F. Deformation of a pyrometric cone signals the end of the cycle.

Changes that take place during firing are physical rather than chemical. As the temperature of the brick increases, the sodium silicate binder eventually becomes a viscous liquid, and at the end of the firing cycle the fly ash components undergo vitrification.

Percentage of carbon in the fly ash is quite important. Excessive carbon tends to retard oxidation of the iron and leaves voids that make the brick too absorptive.

Firing oxidizes the ferrous iron in fly ash bricks to the ferric state, changing the color from gray to red.

## Properties

Tests of the fly ash bricks were conducted in accordance with ASTM specifications for face brick C67-62. Determined were the following: (1) Compressive breaking strength, a measure of flatwise crushing strength; (2) saturation coefficient, the ratio absorption by 24-hour submersion in cold water to absorption by 5-hour submersion in boiling water; (3) water absorption, the amount of water absorbed in 24 hours of soaking and amount of water absorbed in 5 hours of boiling; (4) shrinkage, ratio of the fired length to green length; (5) initial absorption rate (suction), an indication of the degree of bonding between brick and mortar, grams $H_2O$/30 sq in./min; and (6) bulk density.

Table 20 gives a comparison of the physical properties of clay brick and fly ash brick.

TABLE 20. - Physical properties of clay brick and fly ash brick

| ASTM standard specifications | ASTM grade NW clay brick | ASTM grade MW clay brick | ASTM grade SW clay face brick | Fly ash brick[1] |
|---|---|---|---|---|
| Compressive breaking strength, psi......... | 1,500 | 2,500 | 3,000 | 3,000-20,000 |
| Saturation coefficient. | ([2]) | .88 | .78 | .72-.86 |
| Water absorption, pct.. | ([2]) | 22 | 17 | 14-22 |
| Shrinkage.............. | ([3]) | ([3]) | ([3]) | .5 |
| Initial absorption rate | - | - | - | 75-300 |
| Bulk density........... | 130-160 | 130-160 | 130-160 | 90-120 |

[1]Varied depending on fly ash source, slag, sodium silicate, and manufacturing conditions.
[2]No limit.
[3]Standard not established; shrinkage probably higher than that for fly ash brick.

## Fly Ash-Clay Brick

Fly ash-clay brick manufacture also has been the subject of investigation (49). Although clay bricks are not altered chemically by the fly ash, both the mineral content and size consist of the clay are affected. An excessively sticky clay with a high mineral content would benefit from addition of fly ash because the mixture is easier to extrude. On the other hand, a clay that is too mild and silty (containing only a small percentage of clay minerals), if mixed with fly ash, may result in production of an excessively weak brick.

Clay-fly ash bricks were produced and tested in a series of investigations in which fly ash was added in varying amounts to surface clay and shales at convenience points upstream from the pug mills (49). Trials were first carried out in a plant which used shale as a raw material, an extrusion machine (without de-airing facilities), and an automatic face cutter. Clay-fly ash mixtures containing up to 75 percent by weight of ash were investigated. The green bricks were stacked on dryer cars, run through a tunnel dryer, and then fired in beehive kilns. The firing cycle was 5 days with a maximum temperature of 1,875° F. Coal was used as the fuel. Over a period of several months nearly 100,000 bricks were produced.

Although the results varied widely, in all instances satisfactory products were obtained with respect to strength, structure, absorption, and other physical properties. Much difficulty was encountered with the formation of scum that made an undesirable surface discoloration precluding their commercial usage. Mixing fly ash with certain clays or shales apparently causes a base exchange reaction liberating soluble salts that come to the surface during the drying operation, thereby producing the scum. Other investigators have also reported the scum condition as one of the chief objections to the use of fly ash in clay mixtures. A descumming agent developed at the School of Ceramics, Rutgers University, reportedly will eliminate this difficulty.

Fly ash utilization in another plant was considered as a possible way to extend a rapidly dwindling supply of raw material. This plant used loam with some surface clay for raw material and was equipped with an extrusion machine (without de-airing attachment) and an end cutter. Bricks for testing were made from mixtures of 25 percent fly ash and 75 percent loam and 50 percent fly ash and 50 percent loam, the latter being added to develop sufficient plasticity and workability. The bricks were sent through a waste-heat tunnel dryer then fired in coal-burning scove kilns. The firing cycle was 7 days with a maximum temperature of 1,850° F.

Mixtures containing 50 percent fly ash could be readily formed into brick at a 20-percent increase in production rate. The bricks were superior in structure and also showed uniform improvement over the entire kiln. Use of fly ash eliminated structural laminations found in the normal clay brick made in this plant. A small amount of descumming agent was also used in the tests.

Locale for another test series was a small brickyard equipped with a soft mud brick machine and utilizing a low-grade surface clay, up to 75 percent of which was replaced with fly ash. The bricks were dried on pallets and fired in a Dutch-type scove kiln with a 7-day firing cycle and a maximum temperature of about 1,800° F. Coal was used as the fuel and about 40,000 bricks were produced.

No difficulty was encountered in forming, molding, or firing, and the resulting bricks were very similar in physical characteristics and appearance to the normal product. Practically no scum resulted from mixing fly ash with this clay.

A final test series was concerned with the manufacture of handmade colonial brick (58). Mixes containing up to 100 percent fly ash were produced in a modified concrete mixer. Bricks thus produced were hand-thrown into sanded molds, ejected onto pallets, dried, then fired with the regular plant output in standard beehive kilns (using coal as fuel). The firing cycle was about 4 days, and the maximum temperature was 1,920° F.

Attractive handmade colonial bricks were formed from mixtures of fly ash and clay. The absorption of these bricks was approximately 12 percent; compressive strength ranged from 3,000 to 5,000 psi. The brick ranged in color from a light red-buff to a dark red-purple, depending upon the amount and kind of fly ash and firing conditions. Various esthetic effects, such as those obtained by flashing or by firing so as to obtain a stippled effect, were suggested as possible.

Structurally, the products were equal to those produced from clay and shale in the same plant operation, and the physical properties of the brick conformed to the properties of brick normally encountered commercially. The bricks were found easy to handle and from the bricklayer's standpoint they were the same as standard brick.

The firing cycle of a clay-fly ash brick was found to be more favorable than that for clay brick--both the maximum temperature and rate of temperature rise were higher--but the quality of the fly ash bricks fell off rapidly as the temperature was lowered.

Absorption (weight-percent) increased with increase in ash content, which is an unfavorable characteristic.

## Fly Ash-Slag Brick

Minnick and Bauer evaluated bricks composed of fly ash and boiler slag plus small amounts of binder to give the brick additional green strength (49). Initial field tests of these fly ash-slag bricks were performed in a shale plant using a Chambers extrusion machine with de-airing attachment and an automatic face cutter. Standard dryer cars were used and run through a commercial waste-heat tunnel dryer. Coal-burning, standard downdraft periodic kilns were utilized, the firing cycle was 7 days, and the maximum temperature reached was 1,950° F.

Modern de-airing equipment was shown to perform well with fly ash-slag compositions. The body was formed with the same ease as the shale the plant normally used by the plant, and no difficulty was encountered in stacking, drying, or firing. Addition of 1 percent high-swelling bentonite resulted in a body with good workability and satisfactory green strength which handled well in the standard brickmaking equipment. Moreover, the final fired strength of the brick was not greatly affected by the presence of this additive. Table 21 compares physical characteristics of the product with those of shale brick made under the same conditions in the same brickyard.

TABLE 21. - Properties of fly ash-slag brick fired to 1,900° F and standard shale brick

| Properties | Fly ash-slab brick | Standard shale brick |
|---|---|---|
| Compressive strength, psi.. | 6,000-8,000 | 4,000-8,000 |
| Modulus of rupture, psi.... | 1,600-1,800 | 500-2,000 |
| Water absorption, pct...... | 8-10 | 8-12 |
| Saturation coefficient..... | .78 | .78-.90 |
| Color...................... | Light to dark red. | - |
| Efflorescence (McBurney)... | None.............. | - |
| Freezing and thawing (ASTM) | No breakage or weight loss after 50 cycles. | - |
| Weatherometer (equivalent to 7 years' exposure). | No breakage or weight loss. | - |

Fly ash-slag bricks were also made in a plant which normally used surface clay as a raw material, a normal system of rolls and crushers, a large Fate-Root-Heath extrusion machine with de-airing attachment, and an automatic face cutter. A continuous-type dryer and firing equipment was also used. "Bunker C" fuel oil was used with a firing cycle of 30 hours, and the maximum temperature was 1,920° F.

Some difficulty was experienced in removing these bricks from the off-bearing belt because of rapid extrusion rate and a shortage of personnel. The bricks, therefore, were somewhat roughly handled and did not conform in appearance to the standard product produced in this plant. However, the product handled very well in the drying and firing cycle.

Table 22 shows some of the physical properties. Attempts to flash this brick produced a very satisfactory variegated surface coloration.

TABLE 22. - Characteristics of fly ash-slag brick fired to 1,920° F in a 30-hour cycle

| Sample | Weight | | Absorption | | Saturation coefficient |
|---|---|---|---|---|---|
| | Lb | Oz | 24-hr, room temp. | 5-hr, boiling | |
| 1............ | 6 | 10 | 8.87 | 12.38 | 0.72 |
| 2............ | 6 | 7 | 11.54 | 14.74 | .78 |
| 3............ | 6 | 8 | 7.89 | 12.26 | .64 |
| 4............ | 6 | 9 | 10.26 | 13.97 | .73 |
| Average... | 6 | [1]9 | - | - | - |

[1]Due to lack of firing shrinkage, bricks made in normal clay dies are oversized.

Note: The color is attractive red with variegated effects.

Several bricks were also prepared in a 9-in. hand-operated press to evaluate dry press possibilities. Compositions ranged from 100 percent fly ash

down to 50 percent fly ash, with the balance consisting of slag. The bricks were processed in a tile plant under production conditions and fired in an oil-fired tunnel kiln. Maximum temperature was 2,200° F; total firing cycle was 48 hours. A satisfactory brick was produced, indicating that an acceptable product could be obtained by commercial dry press operations. Results of the test are given in table 23.

TABLE 23. - Fly ash-slag brick prepared in hand-operated press

| Mix proportion, wt pct | | Slag preparation | Observation | | Weight (average) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | After drying | After firing | Dry | | Firing | |
| Fly ash | Slag | | | | Lb | Oz | Lb | Oz |
| 100 | 0 | None....... | Good; edges soft. | Some fine checks. | 6 | 14 | 6 | 8 |
| 75 | 25 | Crushed, <10 mesh. | Good green strength.[1] | A few fine checks. | 7 | 10 | 7 | 4 |
| 50 | 50 | ....do..... | ....do.[1].... | Good structure | 7 | 14 | 7 | 7 |

[1] Unfired.

## Fly Ash-Sand Bricks

Bricks made of fly ash and sand were investigated by Manuel Mateos (40). These bricks were unfired and utilized selected fly ashes as a source of cementing material. Fly ash at one time was not considered cementitious, but some fly ashes have been found to contain enough lime to exhibit pozzolanic reactivity.

Three fly ashes and two sands were utilized in the tests. Selection of the former was based on previous studies with soil-fly ash specimens moist-cured at ambient temperature (41). Analyses of the fly ashes are given in table 24. Fly ash A was collected by cyclone-type precipitators servicing equipment in which coal had been pulverized and burned in suspension. Fly ash B was collected by multicone dust precipitators and was derived from Iowa coal that was unwashed, pulverized, and fired tangentially. Fly ash C, also collected by cyclone-type precipitators, came from coal from Missouri and Kansas mines that had been pulverized and burned in suspension.

TABLE 24. - Fly ash analyses[1]

| Fly ash | Constituent | | | | | | | Passing No. 325 sieve, pct | Specific gravity, g/cu cm | Specific surface, g/cu cm |
|---|---|---|---|---|---|---|---|---|---|---|
| | $SiO_2$ | $Fe_2O_3$ | $Al_2O_3$ | CaO | MgO | $SO_2$ | C | | | |
| A | 39 | 30 | 12 | 12 | 0.8 | 1.9 | 2.8 | 57 | 2.33 | 1,730 |
| B | 40 | 27 | 13 | 6 | .3 | 2.4 | .2 | 32 | 2.82 | 1,460 |
| C | 45 | 43 | 8 | 5 | .9 | 1.4 | 3.8 | 65 | 2.69 | 2,048 |

[1] Quantities to nearest percent except MgO, $SO_2$, and C.

One of the sands was a dune sand of uniform size; the other was a well-graded concrete sand. Gradation of both are given in table 25.

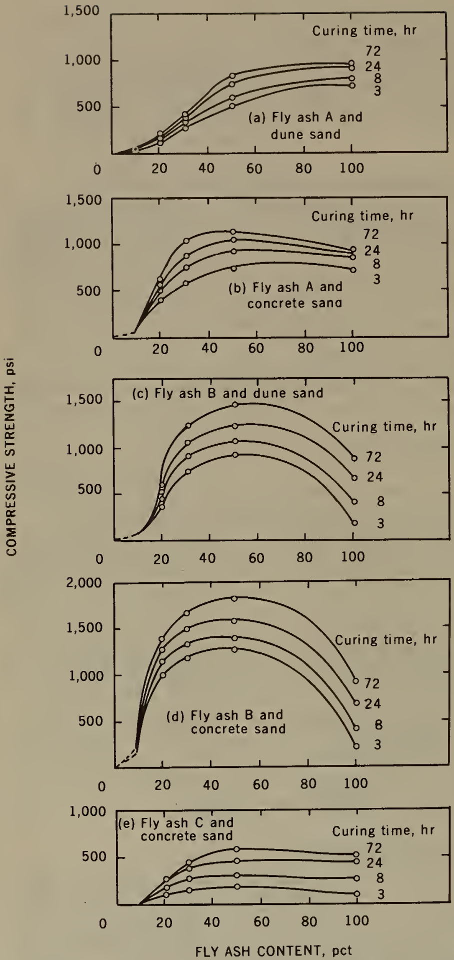


FIGURE 16. - Unconfined Compressive Strengths After Immersion of Sand-Fly Ash Mixtures, Steam-Cured (127° C, 26 psi) for Several Periods.

TABLE 25. - Size consist of sands

| Sieve No. | Dune sand, pct through | Concrete sand, pct through |
|---|---|---|
| 4 | 100 | 100 |
| 10 | 100 | 89 |
| 20 | 100 | 42 |
| 40 | 94 | 15 |
| 100 | 21 | 2 |
| 200 | 4 | 1 |

The results, presented in figure 16, indicated that effective cementation of the sand took place when it was mixed with the fly ashes. The 1,500-psi level was reached with sand specimens that were mixed with fly ash B and cured for 72 hours (fig. 16 (c) and (d)). The 1,000-psi level was reached with fly ash B with both sands and with fly ash A with concrete sand (fig. 16 (b), (c), and (d)). With fly ash C, the highest strengths obtained were about 500 psi after 72 hours of curing (fig. 16 (e)).

Optimum fly ash amounts depended on the type of ash and appeared to be 30 to 50 percent.

Mateos' work established that selected cementitious fly ashes can be used with sand, and probably other soils, to make construction bricks or blocks. Strengths obtained with the fly ashes tested were not very high, but considering that fly ash is a waste material, sand-fly ash bricks may be a useful construction material for some purposes. The findings of this investigation may be of importance to countries where labor is cheap and where the fly ashes have cementitious qualities. Based on past experience with the performance of other bricks, it can be assumed that a strength of 1,500 psi will make the bricks durable under any environmental conditions (40).

A fly ash that is to be used without lime in the preparation of sand-fly ash bricks should be carefully selected. The best way to determine the suitability of a fly ash is by using specimens molded under different moisture contents for several sand and fly ash combinations cured by steam for varying time periods. Strength tests of such specimens will indicate if the fly ash is cementitious and will also show optimum moisture content (for molding) and curing times for different strengths (40).

## MINERAL WOOL

Under a grant from the U.S. Bureau of Mines Solid Waste Program, the West Virginia University Coal Research Bureau conducted a bench scale study of coal ash slags and fly ashes to investigate the feasibility of producing mineral wool from these materials (76). Ash samples for the study were collected from powerplants in different areas of the United States in order to obtain a broad representation of raw material.

Coal ash wool fibers were obtained by blowing the molten ash with a stream of compressed air. Fiber quality and characteristics, as determined according to U.S. Department of Commerce Commercial Standards (CS-131-46) were claimed to be equal to commercial grade mineral wool. Additional claims for coal ash included the possibility of manufacturing wool fibers without adding fluxes to the melt and the advantageous location of powerplants with respect to potential markets.

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## APPENDIX A.--METHOD (TVA) OF PROPORTIONING CEMENT AND FLY ASH (15)

This method is intended only for proportioning cement and fly ash and does not deal with the proportioning of aggregates or the determination of the basic water requirements. The procedure is applicable regardless of the efficiency and inefficiency of proportioning aggregates. It assumes that the quantity and gradation of the coarse aggregate is the same in comparable mixes and that the difference in yield due to the larger volume of cementitious material in the fly ash mix is balanced by a reduction of the sand content. When the quantity of coarse aggregate differs in comparable mixes, adjustments will be required to account for this difference.

### Designing for a Required Strength

Step 1.--Select the volume of coarse aggregate per unit volume of concrete from table 6 of ACI 613-54 (5). In making this selection the fineness modulus of the sand should be reduced by 0.20 to allow for the effect of the larger volume of cementitious material in the fly ash mix.

Step 2.--Estimate the water requirements for the maximum size of aggregate to be used and the required slump. (Use ACI 613-54 as a guide.)

Step 3.--Select from figure A-1 the water-cement ratio required for a given strength concrete.

Step 4.--Select the fly ash proportion to be used. For economic considerations use either figure A-2 or A-3, using the appropriate relative cost of fly ash and required strength to select the fly ash proportion.

Step 5.--Using the water-cement ratio of step 3 and fly ash proportion of step 4, determine the water reduction from figure A-4 or A-5.

Step 6.--Using the estimated water requirements of step 2 for the control mix, determine the water requirements of the fly ash mix by using the water reduction of step 5.

Step 7.--Determine the cement requirements of the control mix by dividing the control mix water requirements by the water-cement ratio of step 3.

Step 8.--Select the proportionate cement requirement of the fly ash mix from figure A-6 or A-7 (depending on the age-strength requirements), using the water-cement ratio of step 3 and the fly ash proportion of step 4.

Step 9.--Using methods in ACI 613-54, determine the solid volume of sand for the mix by subtracting the solid volumes of coarse aggregate, cement, fly ash, and water plus the required volume of air from the unit volume of concrete in the mix.

Step 10.--Check the mix for slump and air content and repeat the procedure for the actual water required to provide the desired slump and air content.

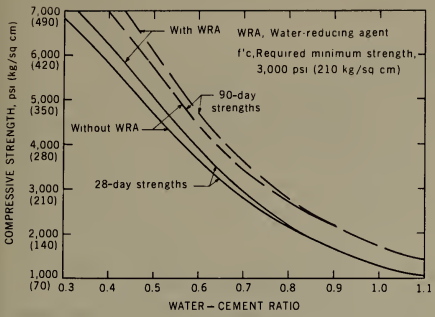


FIGURE A-1. - Water-Cement Ratios Versus Strengths of Control Mixes for Average Type II Cement, Limestone Sand, and 7.5 Percent ± Mortar Air Content.

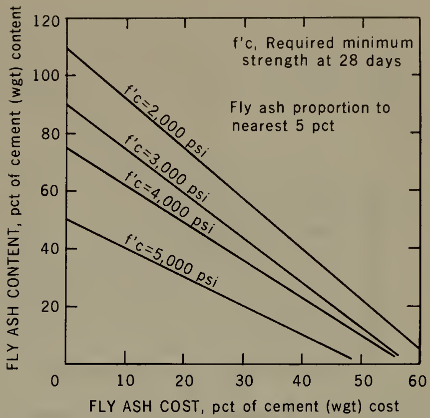


FIGURE A-2. - Economic Proportions of Fly Ash for 28-Day Strength Concrete.

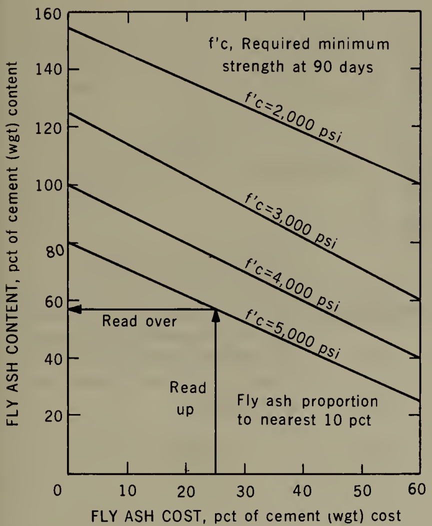


FIGURE A-3. - Economic Proportions of Fly Ash for 90-Day Strength Concrete.

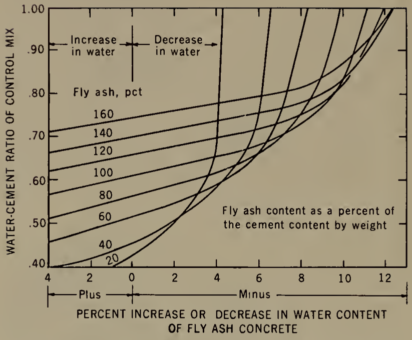


FIGURE A-4. - Comparison of Water Requirements of Concrete, With and Without Fly Ash, Equally Proportioned for 28-Day Strength, Identical Slump, and Air Contents.

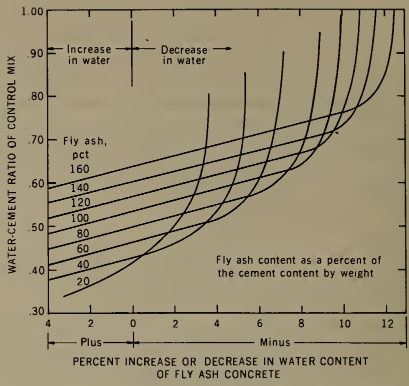


FIGURE A-5. - Comparison of Water Requirements of Concrete, With and Without Fly Ash, Equally Proportioned for 90-Day Strength, Identical Slump, and Air Contents.

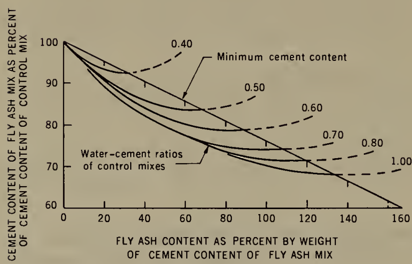


FIGURE A-6. - Cement Requirements for Various Fly Ash Proportions of Concrete Equally Proportioned for 28-Day Strength, Identical Slump, and Air Contents.

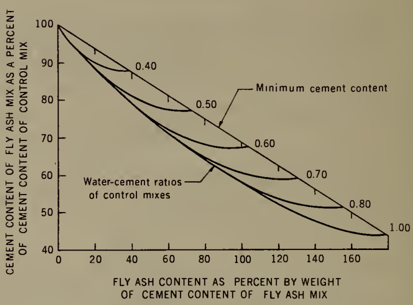


FIGURE A-7. - Cement Requirements for Various Fly Ash Proportions of Concrete Equally Proportioned for 90-Day Strength, Identical Slump, and Air Contents.

Step 11.--If trial mix strengths differ significantly from the required strength, an adjustment in cement and fly ash contents will be required in the final mix. This adjustment is in direct proportion to the water-cement ratio in figure A-1 corresponding to the trial mix strength divided by the original water-cement ratio used in design.

## Example Problem

Design a 28-day, 3,000-psi (210 $kg/cm^2$) concrete with 1-1/2-in. (38 mm) maximum size aggregate, 5 percent air content, 2-1/2-in. (64 mm) slump, no water-reducing agent, fly ash cost at 25 percent of cement cost.

Step 1.--Assume table 6 of ACI 613-54 requires 12 cu ft (0.34 $m^3$) of coarse aggregate or 2,000 lb (905 kg) for specific gravity of 2.67.

Step 2.--From table 3 of ACI 613-54, approximately 30 gal or 250 lb (113 kg) of water are required in the control mix.

Step 3.--From figure A-1, water-cement ratio = 0.59 for 3,700 psi (260 $kg/cm^2$) strength.

Step 4.--From figure A-2, for fly ash cost at 25 percent of the cement cost, the economical proportion of fly ash is 50 percent of the cement content by weight.

Step 5.--From figure A-4, the water reduction is 4 percent for a water-cement ratio = 0.59 and fly ash at 50 percent.

Step 6.--Water content of fly ash mix is 250 (0.96) = 240 lb 113 (0.96) = 108 kg.

Step 7.--Control mix cement = $\frac{250}{0.59} = 425$ lb.

$$\frac{113}{0.59} = 192 \text{ kg.}$$

Step 8.--From figure A-6, the fly ash mix cement content = 82 percent for water-cement ratio = 0.59 and 50 percent fly ash.

Fly ash mix cement = 0.82 (425) = 348 lb.

0.82 (192) = 157 kg.

Fly ash content = 0.5 (348) = 174 lb.

0.5 (157) = 79 kg.

Step 9.--Calculate weights and volumes of concrete ingredients.

| Ingredient | Weight | | Volume | |
|---|---|---|---|---|
| | Lb | Kg | Cu ft | Cu m |
| Coarse aggregate | 2,000 | 905 | 12.00 | 0.340 |
| Cement.......... | 348 | 158 | 1.76 | .050 |
| Fly ash......... | 174 | 79 | 1.16 | .033 |
| Water........... | 240 | 109 | 3.48 | .098 |
| Air............. | - | - | 1.35 | .038 |
| Subtotal..... | - | - | 19.75 | .560 |
| Sand (specific gravity = 2.65) | 1,200 | 545 | 7.25 | .205 |
| Total........ | 3,962 | 1,796 | 27.00 | .765 |

Step 10.--Assume actual slump is within ±1/4 in. of design slump. No adjustment necessary.

Step 11.--Assume trial mixes had an average strength of 4,000 psi (280 kg/cm$^2$) instead of 3,700 psi (210 kg/cm$^2$).

From figure A-1, 4,000 psi (280 kg/cm$^2$) corresponds to a water-cement ratio of 0.56. Adjustment = $\frac{0.56}{0.59}$ = 0.95 for trial mix strength.

Or control mix requires:

0.95 (425) = 404 lb cement.

0.95 (192) = 182 kg cement.

Final fly ash requires 0.95 (348) = 330 lb cement and 165 lb fly ash.

0.95 (157) = 149 kg cement and 75 kg fly ash.

Sand adjustment = +0.15 cu ft (0.004 m$^3$).

# APPENDIX B.--PROCEDURE FOR DETERMINING STRENGTH AND DURABILITY OF STABILIZED SOILS (78)

Strength.--Preparation of trial mixes in the laboratory begins with simulated field mixing. For convenience, soil is air-dried and pulverized to pass the No. 4 or No. 10 sieve. Additives are added, usually in the order of pozzolan, lime, water or the lime and water can be combined into a slurry. Dry mixing usually precedes the addition of water. Kind and amount of mixing should be adjusted to correlate with the expected field procedure. Commonly, kitchen-type mixers are used, for periods of 1 to 5 min. In-place field mixing periods are seldom longer than 3 min and usually 20 sec to 2 min because of economic factors. Because laboratory mixing is frequently more efficient than field mixing, laboratory mix strengths can be cut by a uniform factor, for example, 20 percent, to give expected field strengths. Another alternative is to mix by hand until apparent uniformity has been obtained; this method has given accurate correlations with soil-lime-fly ash field mixes.

After the mix is prepared, specimens are molded, the number required depending on the anticipated test. The molding procedure is also tied in with the method of test. Since the maximum thickness of the soil layer for uniform compaction is only 1 to 2 in., 2-in.-long by 2-in.-diameter specimens are convenient for fine-grained soils. Larger specimens are scarified between layers to minimize development of separation planes.

Curing.--Curing of specimens requires temperature and humidity control and protection against entry of carbon dioxide. Although temperatures are recognized to fluctuate in the field, they are more conveniently held constant in the laboratory. Common practice is to use 70°±3° F. Accelerated curing (curing at 140° F) has been used to predict 28-day strengths of certain soil-lime-fly ash mixtures after 7 days, but the method involves certain risk unless the ingredients are known to react according to this rule. (Some mixes which react well at 140° F have been found to be practically unreactive at ordinary temperatures.)

Relative humidity for curing is usually specified at 100 percent. An alternative procedure is to simulate field wetting and drying, known to be beneficial to pozzolanic reactions. Entry of carbon dioxide is prevented by wrapping specimens in plastic film or sealing them in cans. These procedures also protect against drying. For design purposes the length of the curing period is usually from 7 to 28 days, although strengths keep gaining indefinitely or until final depletion of the lime.

Strength and Durability.--After curing, stabilized soil specimens are tested for strength or durability. Specimens for strength tests may be tested immediately (ASTM Designation C109-58) or may be first subjected to a simulated most-severe-field-service condition. Examples of the latter are to soak specimens in water up to 1 day or subject them to capillary water for several days. The method of the Texas Highway Department is to finally oven-dry soil-lime at 140° F to simulate worst conditions of summer heat and then to subject it to capillary absorption.

Both apparent cohesion and angle of shearing resistance may be determined from triaxial strength tests. At least three and preferably six specimens are required for determination of the Mohr envelope. The Hveem stabilometer used by the California Division of Highways is a triaxial testing device which measures combined effects of cohesion and internal friction. These methods are most important for gravelly and sandy soils which have granular stability.

Cementation reactions contribute most directly to cohesion, and shorter test methods for cohesion are widely used for preliminary mix evaluation. The unconfined compression test measures mainly cohesion. Common specimen sizes are 2 in. diameter by 2 in., 2 in. diameter by 4 in., 4 in. diameter by 4.56 in. (standard Proctor mold size), and 6 in. diameter by 8 in. At least three specimens are required for each test. Average strengths are reported in pounds per square inch. A height:diameter ratio correction can be applied for specimens having a ratio less than 2:1, but frequently this is not done. Large, well-stabilized specimens require preliminary capping with Celotex or plaster of paris to distribute stresses more uniformly.

A direct measure of cohesion is the maximum tensile stress at breaking, for example, by means of the Hveem cohesionmeter.

Shearing resistance is measured indirectly by the California bearing ratio, an empirical punching-shear test for pavement-design purposes.

Simulated weathering treatments for stabilized soil include alternate wetting and drying or alternate freezing and thawing. These treatments are usually patterned after those for soil cement (ASTM Designation D559-57 and D560-57), except that wire brushing of specimens between cycles is sometimes eliminated. Because wet-dry cycles nearly always increase rather than decrease the strength, they are frequently eliminated from the testing program. Freezing and thawing are most destructive when there is a ready availability of water, as when specimens rest on wet felt. Water in the pores expands on freezing and acts to separate cemented grains. Freeze-thaw action is most severe when conditions are near saturation, as in small specimens or near bottoms of larger specimens stored on wet felt.

Evaluation of durability is made either from the reduction in strength after weathering cycles or by measuring the weight loss of loose material from the specimens. In the latter procedure wire brushing is employed between cycles. Strength loss can be measured directly by breaking specimens after the specified number of cycles, or it can be arrived at indirectly by non-destructive pulse-velocity measurements of specimens. An advantage of the latter is that it allows reevaluation of a specimen after each weathering cycle.

The appropriate number of weathering cycles depends on climate and expected thickness of cover. The number of freeze-thaw cycles during any given period can be calculated from daily temperatures and soil thermal constants (1). The number of cycles decreases rapidly with depth. In a temperature area conservative maximums are 12 freeze-thaw cycles for a base course under a 2-in. surfacing or four cycles for a subbase.

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# RESPIRABLE DUST SAMPLING REQUIREMENTS UNDER THE FEDERAL COAL MINE HEALTH AND SAFETY ACT OF 1969

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

July 1970

# RESPIRABLE DUST SAMPLING REQUIREMENTS UNDER THE FEDERAL COAL MINE HEALTH AND SAFETY ACT OF 1969

By Donald P. Schlick and Robert G. Peluso

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# RESPIRABLE DUST SAMPLING REQUIREMENTS UNDER THE FEDERAL COAL MINE HEALTH AND SAFETY ACT OF 1969

by

Donald P. Schlick[1] and Robert G. Peluso[2]

## ABSTRACT

Respirable dust provisions of the Federal Coal Mine Health and Safety Act of 1969 are designed to protect the most important resource of the coal mining industry--its workers. The Act imposes two respirable dust standards of 3.0 milligrams per cubic meter of air after June 30, 1970; and 2.0 milligrams per cubic meter of air after December 30, 1972.

Under Federal regulations, each operator is required to carry out a dust sampling program established by the Secretary of the Interior and the Secretary of Health, Education, and Welfare. This program features the sampling of "high risk" face workers to establish that the exposure of each miner is below the dust standard. Mining sections, continuously in compliance with the regulations, may sample at less frequent intervals.

In addition to requiring the mining company to take respirable dust samples, the Bureau of Mines will perform in-depth dust inspections twice a year, as well as frequent "spot inspections."

The Bureau has established a semiautomatic computerized operation capable of processing over 1 million samples per year. This facility will be linked to various Bureau offices by a telecommunications system to provide automatic data printouts within hours after samples have been weighed.

## INTRODUCTION

The inhalation and retention of coal mine dust in the lungs can result in the development of coal workers' pneumoconiosis. Results of a recent study by the Publich Health Service, Department of Health, Education, and Welfare, indicates that 3 percent of the active miners in underground bituminous-coal mines and 9 percent of the inactive miners have a complicated form of coal

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workers' pneumoconiosis. The results also indicate that 10 percent of the active miners and 19 percent of the inactive miners have some form of the disease. When examining the relationship between the incidence of the disease and the years of exposure, the results indicate that the incidence of the disease in the active workers increase sharply for those who have worked more than 30 years underground and in the inactive workers a sharp increase is indicated after 20 years of underground work. These results suggest that the accumulation of coal mine dust in the lungs of the miners is responsible for the development of the disease.

To establish the concentration of respirable dust to which coal miners were being exposed, the Bureau of Mines in April 1969 initiated a study of dust exposures in selected underground bituminous-coal mines. At that time, the basic reason for implementing this study was to develop, on an occupational basis, respirable dust exposures. These concentrations, determined on an occupational basis, would provide valuable data to the Public Health Service in correlating X-ray evidence to the incidence and prevalence of coal workers' pneumoconiosis.

Primary findings of this study indicated that occupations involved in the extraction of coal were exposed to the highest dust concentrations. Table 1 lists the distribution of dust concentrations by occupation as measured with the personal sampler.

TABLE 1. - Mine mean dust concentrations by occupation: Samples taken with the personal sampler

| Occupation | No. of mines | No. of samples | Dust concentration, mg/m$^3$ | | | | Concentration, mg/m$^3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | <1.6 | 1.61-2.4 | 2.41-2.9 | >2.9 | Low | High | Mean |
| Continuous miner operator | 21 | 178 | 2 | 2 | 4 | 13 | 0.02 | 21.44 | 4.08 |
| Continuous miner helper.. | 19 | 131 | 4 | 3 | 2 | 10 | .44 | 18.90 | 3.47 |
| Cutting machine operator. | 15 | 98 | 1 | 6 | 2 | 6 | .71 | 15.42 | 3.69 |
| Cutting machine helper... | 8 | 37 | 1 | 3 | - | 4 | .77 | 14.70 | 4.45 |
| Coal drill operator...... | 9 | 59 | 3 | - | 1 | 5 | .42 | 12.94 | 3.55 |
| Loading machine operator. | 18 | 97 | 2 | 1 | 2 | 13 | .25 | 39.56 | 3.75 |
| Loading machine helper... | 6 | 31 | - | 3 | - | 3 | .50 | 14.48 | 3.17 |
| Roof bolter operator..... | 25 | 296 | 6 | 9 | 6 | 4 | .09 | 38.50 | 2.46 |
| Shuttle car operator..... | 27 | 463 | 17 | 7 | 3 | - | .12 | 10.50 | 1.45 |
| Beltman.................. | 7 | 32 | 2 | 3 | 1 | 1 | .42 | 4.97 | 1.85 |
| Boomboy.................. | 6 | 20 | 5 | - | - | 1 | .23 | 5.88 | 1.30 |
| Timberman................ | 12 | 49 | 7 | 1 | - | 4 | .38 | 11.74 | 2.49 |
| Shotfirer................ | 12 | 83 | 5 | 2 | 2 | 3 | .62 | 56.97 | 3.15 |
| Supplyman................ | 8 | 24 | 5 | 1 | 1 | 1 | .05 | 9.36 | 1.59 |
| Mechanic................. | 19 | 142 | 17 | 2 | - | - | .06 | 5.43 | 1.10 |
| Section foreman.......... | 28 | 236 | 19 | 4 | 2 | 3 | .14 | 14.51 | 1.69 |
| Total.............. | 29 | 1,976 | 96 | 47 | 26 | 71 | - | - | - |
| Percent of total.... | - | - | 40 | 19 | 11 | 30 | - | - | - |

## THE RESPIRABLE DUST STANDARDS

The Congress established in the Federal Coal Mine Health and Safety Act of 1969 the first respirable dust standard ever written in any coal mining law in the United States. The Act set dust standards which are mandatory in each underground coal mine in the United States. The dust standards set were as follows:

1. Effective June 30, 1970, each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner is exposed at or below 3.0 milligrams per cubic meter ($mg/m^3$) of air.

2. Effective December 30, 1972, each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner is exposed at or below 2.0 $mg/m^3$ of air.

Any operator who determines that he will be unable, using available technology, to comply with the standards and adequately fulfills the requirements established by the Compliance Panel established by the Act may be granted a permit to maintain continuously the average concentration at a level the Compliance Panel sets, but in no event shall the level exceed 4.5 $mg/m^3$ of air when the 3.0 $mg/m^3$ of air standard is in effect or 3.0 $mg/m^3$ of air when the 2.0 $mg/m^3$ of air level is in effect.

The average respirable dust concentration of 4.5 $mg/m^3$ of air, 3.0 $mg/m^3$ of air, and 2.0 $mg/m^3$ of air refer to dust concentrations measured with an MRE instrument, or equivalent concentrations if measured with another device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare.

In order to comply with dust standards, the Act requires that the operator of each coal mine take accurate dust samples and that the representative of the Secretary of the Interior make periodic and spot dust inspections. The samples shall be collected by the MRE instrument or a device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare and in accordance with such methods, at such locations, at such intervals, and in such a manner as the Secretaries prescribe.

## PERMITS OF NONCOMPLIANCE

The Act establishes the Interim Compliance Panel which is composed of five members as follows:

1. Assistant Secretary for Wage and Labor Standards, Department of Labor, or his delegate;

2. Director, Bureau of Standards, Department of Commerce, or his delegate;

3. Administrator, Consumer Protection and Environmental Health Service, Department of Health, Education, and Welfare, or his delegate;

4. Director, Bureau of Mines, Department of the Interior, or his delegate; and

5. Director, National Science Foundation, or his delegate.

The Interim Compliance Panel shall issue permits and renewal permits for noncompliance. Permits will be issued if the applicant satisfies the following requirements, and if the Interim Compliance Panel determines that the applicant will be unable to comply with the standard.

1. A statement by the applicant and a certified engineer that the applicant will be unable to comply with the applicable dust standard due to the unavailability of technology for reducing the respirable dust.

2. Identification of the working places for which the permit is requested, the results of an engineering survey in the section by a certified engineer, and a description of the engineering parameters affecting respirable dust concentrations.

3. Statements by the applicant and a certified engineer of the future plans for reducing the respirable dust concentrations.

Permits must be filed 60 days prior to the effective date of the applicable respirable dust standard and in the case of renewal permits, 60 days before the permit expires. Permits or renewals shall not exceed a maximum time period of 1 year. When the 3.0 $mg/m^3$ of air standard is in effect, no permit or renewal shall be extended beyond June 30, 1971. When the 2.0 $mg/m^3$ of air standard is in effect, no permit or renewal shall be extended beyond December 30, 1975.

The Interim Compliance Panel regulations for obtaining a permit of noncompliance were published in the Federal Register (appendix A).

See appendix B for samples of Interim Compliance Panel forms and the directions for completing these forms. Inquiries concerning the Interim Compliance Panel should be addressed to:

Interim Compliance Panel
1730 K Street, N.W.
Suite 800
Washington, D.C. 20006

## APPROVED SAMPLING DEVICES

Heretofore, in the United States, dust concentrations were measured by sampling with the midget impinger and counting the number of particles less than 10 microns in diameter. The concentration was expressed in the number of millions of particles of dust per cubic foot of air. Recent studies have led investigators to believe that the mass concentration of respirable dust is a more meaningful factor for correlation with pneumoconiosis than the previously used counting technique. An important discovery, leading to this conception,

is that the mass of respirable dust extracted from a miner's lungs in an autopsy parallels the miner's severity of pneumoconiosis based on X-ray evidence prior to death.

Although the entire scientific community is not in full agreement with the respirable mass concept, there now seems to be a general agreement that the main factor associated with bituminous-coal workers' pneumoconiosis is the mass of respirable dust inhaled and retained.

If the mass of respirable dust in the atmosphere is the parameter used for hygienic evaluation of dust exposure, then the instruments used to evaluate the atmosphere should simulate the respiratory tract in selecting the dust particles.

At present, there are two criteria accepted for defining respirable dust: The first was recommended and adopted by the Pneumoconiosis Conference in 1959; the second resulted from work performed by the United States Atomic Energy Commission.

Gravimetric sampling devices have been developed that sample in accordance with each of these acceptable criteria. One is called the MRE (Mines Research Establishment) instrument and another is the personal sampler. The MRE samples in accordance with the recommendations of the Pneumoconiosis Conference and the other device simulates the Atomic Energy Commission criteria.

Due to its design and weight, the MRE can best be employed as an instrument to measure the dust concentration in the general environment of the workers, while the personal sampler readily lends itself to measuring the dust concentration in the worker's breathing zone. The two samplers are shown in figure 1. Both instruments are designed to operate over the entire work shift and are usually employed on a portal-to-portal basis. Due to general availability and low cost, more instruments of the personal sampler variety are found employed in bituminous-coal mines in the United States. This particular instrument was designed and constructed in the laboratories of the U.S. Bureau of Mines while the MRE is of British design and manufacture.

Under the Federal Coal Mine Health and Safety Act of 1969, either the MRE or the personal sampler can be used to measure the concentrations of respirable dust. Information concerning specific sampling devices permitted under the Act are discussed later in this report.

## OPERATOR'S SAMPLING PROGRAM

In order to discharge its responsibility under the law, the Secretary of the Interior and the Secretary of Health, Education, and Welfare established an industry-wide operator sampling program.

### Sampling Requirements

The main feature of this program is that every operator of a coal mine will be required to take samples of respirable coal mine dust in each

FIGURE 1. - Mines Research Establishment Gravimetric Sampler and the U.S. Atomic Energy Commission Personal Sampler.

coal-producing section, as well as in other areas generating respirable dust starting June 30, 1970. Initially, each operator is required to collect 10 valid samples which shall constitute a basic sampling cycle in each coal-producing section. Subsequent to this basic sampling cycle, the operator is required to collect five valid samples each month in each coal-producing section which shall constitute a standard sampling cycle.

The operator shall continue to collect a monthly standard sampling cycle during each calendar month, until he is cited for a violation, starts a new section, or the applicable respirable dust standard changes. During each basic or standard sampling cycle, the operator is also required to take one sample of the intake air current to each section. If the Bureau of Mines fails to receive the required valid samples each calendar month, the operator will be advised to submit additional samples to make up the deficiency.

Based on the data and evaluation of its previously mentioned environmental study in bituminous-coal mines, the Bureau of Mines has developed the "high risk" concept. This concept states that if the dust concentration of the worker exposed to the highest respirable dust concentration is below the legislative standard, then it is assumed that all other section workers will be below the standard. The Bureau has determined the "high risk" miner for each coal mining operation.

In conventional coal-producing sections, samples shall be collected in the working environment of the coal cutting machine operator and a sample will be taken in the intake air current to the section.

In continuous coal-producing sections, samples shall be collected in the working environment of the continuous mining machine operator and a sample shall be taken in the intake air current of the section.

In longwall coal-producing sections, samples shall be collected in the working environment of the last miner on the return air side of the longwall face and a sample shall be collected in the intake air current of the section.

In a hand-loaded section, samples shall be collected in the working environment of the hand loader. At least one sample shall be collected on each section; and where there are more than 10 loaders working, additional samples at the rate of one for every 10 men shall be collected. A sample shall also be collected in the intake air current of the section.

The "high risk" occupation can be changed by an authorized representative of the Secretary when data indicates such a change is necessary.

In addition to those samples taken in the section in the environment of the "high risk" miner, all underground miners, regardless of where they work, shall have a number of respirable dust samples collected in their individual working environment.

The schedule for taking these non-high-risk samples is as follows:

1. Non-high-risk workers employed in the section--every 120 days.

2. Nonsection workers employed in other underground occupations--every 180 days.

3. Workers who are advised that they show evidence of pneumoconiosis and exercise their option of moving from a dusty area to a less dusty area--every 90 days.

In multisection mines, the sampling procedure shall be staggered permitting the continuous monitoring of the mine environment. For instance, in a two-section mine, the sampling cycles may be taken during the first half of a calendar month in one section and in the second half of the calendar month on the second section. In non-coal-producing areas, samples may be taken at any time. All respirable dust samples shall be collected over a full shift, portal to portal.

## Reduction in Standard Sampling Cycle

Where analysis of the samples from a basic sampling cycle and a standard sampling cycle from any section of a mine establish that the cumulative respirable dust concentration is below 30 mg/m$^3$, the Secretary of the Interior or his authorized representative may establish an alternating sampling cycle for such section in accordance with the following schedule:

1. First month, samples from basic sampling cycle in compliance.

2. Second month, samples from standard sampling cycle in compliance.

3. Third month, no sampling cycle required.

4. Fourth month, samples from standard sampling cycle in compliance.

5. Fifth month, no sampling cycle required.

6. Sixth month, repeat cycle as provided in item 2 above.

The operator shall revert to the standard sampling cycle if, at any time during a modified sampling cycle, analysis of the samples from the most recent sampling cycle shows the average dust concentration in such section to be in excess of the applicable standard.

## Permissible Sampling Device

Respirable dust samples shall be collected with an MRE instrument, or any other device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare. The following personal respirable dust samplers and sampling heads are approved devices that can be used until December 31, 1970, to measure the dust concentrations.

1. Approved battery-operated sampling pump

   A. Casella Mark II Model B
      Willson Products Division
      P.O. Box 622
      Reading, Pennsylvania 19603

   B. MSA Monitaire Sampler, Model G
      Mine Safety Appliances Company
      201 North Braddock Avenue
      Pittsburgh, Pennsylvania 15208

   C. UNICO Model C110 Pump
      UNICO Environmental Instruments, Inc.
      150 Cove Street
      Fall River, Massachusetts 02720

2. Sampling head

The sampling head consists of a 10-millimeter nylon cyclone and filter assembly mounted in a suitable holder for attaching to the worker. The following equipment meets these requirements.

   A. MSA Gravimetric Dust Sampler
      Mine Safety Appliances Company
      201 North Braddock Avenue
      Pittsburgh, Pennsylvania 15208

   B. Respirable Mass Lapel Sampler
      UNICO Environmental Instruments, Inc.
      150 Cove Street
      Fall River, Massachusetts 02720

After December 31, 1970, only those pumps which fulfill the specifications published by the Secretaries of the Interior and Health, Education, and Welfare in the Federal Register (appendix C) shall be permissible.

An approved coal mine dust personal sampler unit shall be operated at a flow rate of 2.0 liters of air per minute. An MRE instrument shall be operated at a flow rate of 2.5 liters of air per minute.

The concentration of respirable dust expressed in milligrams per cubic meter of air shall be determined by dividing the weight of dust in milligrams collected on the filter by the volume of air in cubic meters passing through the filter. To convert a concentration of respirable dust as measured with an approved coal mine dust personal sampler unit to an equivalent concentration of respirable dust as measured with an MRE instrument, the concentration of respirable dust measured shall be multiplied by a constant factor of 1.6 and the product shall be the equivalent concentration as measured with an MRE instrument.

**MINE DATA CARD**

CASSETTE NO. ____________

INITIAL WT. ____________

MINE ID NO. ____________

FINAL WT. ____________

SECTION ID NO. ____________

SAMPLING TIME (MIN) ____________

MINER'S SSA NO. ____________

OCCUPATION. ____________

TONS THIS SHIFT ____________

TYPE OF SAMPLE

HIGH RISK ________ INTAKE AIR ________

NON-HIGH RISK:

FACE ____ NON-FACE ____ 203 (B)(1) ____

FACE VENTILATION

EXHAUST ________ BLOWING ________

AUXILIARY ________ BRATTICE ________

TYPE OF MINING

DEVELOPMENT ________ RETREAT ________

METHOD OF MINING

CONTINUOUS ________ CONVENTIONAL ________

LONGWALL ________ OTHER ________

________ CHECK IF SECTION WILL CLOSE BEFORE NEXT SAMPLING CYCLE.

SIGNATURE: DATE ____________

(MINER SAMPLED) ____________

(MINE OFFICIAL) ____________

FIGURE 2. - Mine Data Card.

## Location of Sampling Device

The personal sampling device may be worn by the miner with the sampling head attached to his clothing at the chest, or it may be located in the working environment of the miner. If the sampling device is located in the working environment of the designated miner, it shall be positioned on the mining equipment. In this case, the sampling device shall be located on the mining equipment not more than 36 inches from the operator's normal working position, but in no instance shall the device be located outby such operator.

In hand-loading sections when the sampler is not located on the miner, it shall be placed near the miner where the maximum concentration of respirable dust exists.

The sampling device used to take respirable dust samples in the intake ventilating air current shall be located as close to the working face as practicable, but in no instance shall the sampling device be located more than 200 feet outby the face.

The operator shall exercise care with respect to the location of the sampling device to assure that representative respirable dust samples of the mine atmosphere are taken. The MRE instrument shall be kept in a near level position, and the sampling head and cyclone of the personal sampler shall be kept in an upright position while samples are being taken.

## Purchase and Transmission of Samples

A preaddressed mailing container containing the filter cassette must be purchased by the mining company from the dust sampler manufacturer or the filter cassette manufacturer. Each sample shall be transmitted promptly, along with the mine data card, furnished by the filter cassettee manufacturer, certifying specified data as shown in figure 2, to the Bureau of Mines, Pittsburgh Field Health Group, Pittsburgh, Pennsylvania 15213.

Each mine data card accompanying each sample must be filled out accordingly.

1. Cassette Number--Furnished by the filter manufacturing company and must be the same as the number on the filter cassette.

2. Mine Idenfification Number--Furnished to the mining company by the Bureau of Mines.

3. Section Number--A three-digit number assigned by the mining company to each operating section. When the section works out, the mine shall retire this number and assign a new number to the new section.

4. Occupation--The miner's occupation; that is, continuous miner operator, shuttle car operator, etc.

5. Initial Weight--Furnished by the filter manufacturer.

6. Final Weight--Furnished by the Bureau of Mines after weighing.

7. Sampling Time (minutes)--The actual time, portal to portal, that the machine was running (in minutes).

8. Date--Date sample was taken.

9. Tons This Shift--Tons of new coal mined while the sample was being taken.

10. Type of Sample--Check appropriate box. "High risk" is discussed earlier in this report. "Section 203(b)(1)" refers to workers having evidence of pneumoconiosis who elect to work in less dusty areas.

11. Face Ventilation--Check as many boxes as appropriate concerning face ventilation.

12. Type of Mining--Check appropriate box.

13. Method of Mining--Check appropriate box.

14. Check if Section Will Be Closed--This box is to be marked if the section will be closed before the next sampling cycle.

15. Signature--Miner Sampled--Signature of the miner whose environment was sampled.

16. Mine Official--Signature of mine official who was responsible for taking the sample.

## Analysis, Records, and Results

The Bureau of Mines has established in its Pittsburgh field office a semiautomatic weighing facility capable of weighing over 1 million samples per year. The heart of the operation is four electronic balances each on a line with a key tape unit which is programed with the Bureau's computer located in

Denver, Colo. The computer will store the many bits of respirable dust data until called for by the Bureau. This computer is linked to 13 key Bureau locations via telecommunication so that within hours following the Bureau analysis of samples, an automatic data printout shall be available to every Bureau coal mining district and subdistrict office. The printout shall contain the following information.

1. Mine identification number.

2. Section identification number.

3. Results of each sample in $mg/m^3$.

4. Cumulative total of all samples in current sampling cycle.

5. Result of sample of intake air current.

6. Social Security number of miners sampled.

## Violations

If, during samples taken by the operator, in the high risk operation, it is determined that the allowable cumulative concentration of respirable dust is ever exceeded, the Secretary or his authorized representative shall take action in accordance with provisions of Section 104(i) of the Act. For example:

1. If the 3.0 $mg/m^3$ of air standard is in effect, then during the basic 10-sample sampling cycle the average respirable dust concentration must not accumulate more than 30 $mg/m^3$ of air (3.0 $mg/m^3$ $\times$ 10 samples = 30 $mg/m^3$) to be in compliance. If, and as soon as the average respirable dust concentration exceeds this value, the section is in violation. Thus, if on the first sample 15 $mg/m^3$ of air is recorded, and on the second sample 16 $mg/m^3$ of air is recorded, then the section is in violation.

2. If the 3.0 $mg/m^3$ of air standard is in effect, then during the first standard sampling cycle the first sample will be combined with the 10 samples taken in the basic sampling cycle. After adding this sample, the first sample of the basic sampling cycle will be dropped. The last 10 samples shall be considered to determine compliance. If the total of these 10 samples exceed 30.0 $mg/m^3$ of air, the section is in violation.

Thereafter, as each subsequent sample (second, third, fourth, or fifth) is received during a standard sampling cycle, the oldest sample will be discarded and compliance will be determined on the last 10 samples. Thus, every time a new sample is added, a determination is made as to which of the sections are in compliance. The Bureau of Mines computer with a telecommunications system will greatly assist the quick dissemination of this information.

## BUREAU OF MINES DUST INSPECTION PROGRAM

In addition to requiring the operator of a coal mine to establish a respirable dust sampling program, the Bureau of Mines will conduct semiannual respirable dust inspections of each underground coal mine. These inspections may, at the discretion of the District Manager, be made in conjunction with the regular safety inspections or as a separate inspection.

### Respirable Dust Samples

Respirable dust samples shall be collected (1) for miners in all coal-producing sections of the mine and (2) for a representative number, 10 percent, of the miners employed outside the face.

A sampling cycle shall be up to five samples or until the average respirable dust concentration of the high-risk miner has been determined to be in or out of compliance by table 2, 3, or 4, depending upon which standard is in effect. The Bureau will take at least two samples in determining compliance according to these tables.

TABLE 2. - Average of n samples: 3.0 $mg/m^3$ standard

| Sample | Greater than out of compliance | Equal to or less than in compliance |
|---|---|---|
| 1.............. | 15.0 | 0.0 |
| 2.............. | 7.5 | 1.0 |
| 3.............. | 5.0 | 1.6 |
| 4.............. | 3.8 | 2.4 |
| 5.............. | 3.0 | 3.0 |

TABLE 3. - Average of n samples: 4.5 $mg/m^3$ standard

| Sample | Greater than out of compliance | Equal to or less than in compliance |
|---|---|---|
| 1.............. | 22.5 | 0.0 |
| 2.............. | 11.3 | 1.7 |
| 3.............. | 7.5 | 2.6 |
| 4.............. | 5.7 | 3.6 |
| 5.............. | 4.5 | 4.5 |

TABLE 4. - Average of n samples: 2.0 $mg/m^3$ standard

| Sample | Greater than out of compliance | Equal to or less than in compliance |
|---|---|---|
| 1.............. | 10.0 | 0.0 |
| 2.............. | 5.0 | .6 |
| 3.............. | 3.4 | 1.1 |
| 4.............. | 2.5 | 1.6 |
| 5.............. | 2.0 | 2.0 |

The respirable dust samples collected during a shift shall be promptly weighed by the inspector on a suitable balance after the shift is completed.

All respirable dust samples and accompanying data cards from each working section shall be sent to the Pittsburgh Field Health Group for chemical and physical analyses by standard methods to determine the quartz, ash, and metal content of the respirable dust.

The operator will not be required to collect dust samples on coal-producing sections while an authorized representative of the Secretary of the Interior is making a dust inspection of the section.

## Spot Inspections

The Bureau of Mines shall conduct frequently spot inspections of active workings of coal mines. During such inspections, the inspector shall not collect any respirable dust samples. The inspector shall (1) check the dust control program in the section for its overall effectiveness and (2) check the operator's dust sampling program.

## Violations of the Bureau's Inspection Program

If, during a Bureau of Mines dust inspection, an inspector determines, based on a sampling cycle of up to five samples, that the average concentration of respirable dust exceeded the applicable limits listed in table 2, 3, or 4, whichever is in effect, he shall promptly take action in accordance with provisions of Section 104(i) of the Act.

## Records

In addition to collecting respirable dust samples, the inspectors will be required to keep accurate notes and records pertinent to the dust inspection. This shall include:

1. Accurate measurements of the quantity and velocity of the air reaching the last open crosscut between entries or rooms and in the entries or rooms inby the last open crosscut, at the intake end of pillar lines.

2. The method, system, and equipment used for ventilating the face.

3. The quantity and pressure of the water used for dust control.

4. The number, manufacturer, type, and location of water sprays used in the spray system for dust control.

5. The inspector should observe any unusual or successful dust control methods that may be in effect at a mine, and he should forward such information to the District Manager, Bureau of Mines.

6. The inspector shall check the dust control program at the mine for its overall effectiveness. This includes checking the operator's sampling

pumps for the correct flow rate as specified by the Department of Health, Education, and Welfare and the Bureau of Mines.

## SECTION 104(i) OF THE ACT

Section 104(i) of the Federal Coal Mine Health and Safety Act of 1969 states that if, based upon samples taken during a Bureau of Mines inspection by an authorized representative of the Secretary, the applicable limit on the concentration of respirable dust required to be maintained under this Act is exceeded and thereby violated, the Secretary or his authorized representative shall issue a notice fixing a reasonable time for the abatement of the violation. During such time, the operator of the mine shall cause samples described in Section 202(a) of the Act to be taken of the affected area during each production shift.

If, upon the expiration of the period of time as originally fixed or subsequently extended, he shall find the extent of the area affected by the violation and shall promptly issue a withdrawal order until the Secretary or his authorized representative has reason to believe, based on actions taken by the operator, that such limit will be complied with, upon the resumption of production in such mine. As soon as possible after an order is issued, the Secretary, upon request of the operator, shall dispatch to the mine involved, a person or team of persons to the extent such persons are available, who are knowledgeable in the methods and means of controlling and reducing respirable dust. Such person or team of persons shall remain at the mine involved for such time as they shall deem appropriate to assist the operator in reducing respirable dust concentrations. While at the mine, such persons may require the operator to take such actions as they deem appropriate to insure the health of any person in the coal mine.

The law requires each operator to report and certify to the Secretary as to the condition in the active workings of the coal mine. The report form number, 6-1497, enclosed in appendix E, is available at each Coal Mine Health and Safety District and Subdistrict Office.

## CONTROL OF DUST, MISTS, OR FUMES

Permissible dust collectors are those dust collectors that are approved by the Bureau of Mines under Schedule 21-B and maintained in permissible condition. When water or water with a wetting agent is used to control dust from drilling in rock, the water shall be applied directly to the drill bit through a hollow drill steel or stem. If vertical holes are being drilled in the floor, flooding the holes with water will suffice as a dust control method.

Any ventilating air current used to disperse dust caused by drilling in rock shall be so directed that the dust is readily dispersed and carried away from the drill operator or any other worker in the area. Respirators, approved for use in coal mines, shall be provided to persons exposed for short periods to high dust concentrations, to mist inhalation hazards, and to harmful or toxic fumes.

When the exposure is for prolonged periods, other methods such as water or water with a wetting agent or ventilation shall be used to control respirable dust to legislative limits. Mists and fumes created by roof sealing compounds, compounds used to seal stoppings, cleaning fluids, paints, and oil mists created by percussion drills and machinery shall be controlled by ventilation.

## Chapter V—Interim Compliance Panel (Coal Mine Health and Safety)

### SUBCHAPTER A—COAL MINE HEALTH

### PART 501—PERMITS FOR NONCOMPLIANCE

Section 202 of the Coal Mine Health and Safety Act of 1969, which applies to bituminous coal, lignite and anthracite mines, provides that the Interim Compliance Panel may issue permits for noncompliance with the respirable dust standards specified therein. This Part 501, reading as set forth below, is promulgated to prescribe the requirements which must be met by each applicant for an initial permit for noncompliance with the respirable dust standard prescribed for underground coal mines in section 202(b)(1) of the Act and for renewals of such permit. In addition, it sets forth the requirements which must be met by each person requesting a public hearing with respect to the issuance of any permit or renewal thereof.

This Part 501 shall become effective upon its publication in the FEDERAL REGISTER.

CHARLES F. BROWN,
*Chairman, Interim Compliance Panel (Coal Mine Health and Safety Act).*



AUTHORITY: The provisions of this Part 501 issued under Title V, sec. 508, Pub. Law 91–173, Stat. 803.

#### § 501.1 Application of part.

This part applies to applications for permits for noncompliance and renewals thereof submitted in accordance with the provisions of Title II of the Federal Coal Mine Health and Safety Act of 1969, and to requests for hearings conducted with respect to such applications.

#### § 501.2 Definitions.

As used in this part:

(a) "Act" means the Federal Coal Mine Health and Safety Act of 1969 (Public Law 91–173);

(b) "Panel" means the Interim Compliance Panel established by section 5 of the Act;

(c) "Applicant" means any operator of an underground coal mine who files an application with the panel for an initial or renewal permit for noncompliance with the respirable dust standard set forth in section 202(b)(1) of the Act;

(d) Unless otherwise specified in this part, "permit" means an initial permit for noncompliance issued to an applicant, or a subsequent renewal thereof, which entitles the applicant to exceed the respirable dust standard set forth in section 202(b)(1) of the Act with respect to working places designated in such permit or renewal;

(e) "Respirable dust standard" means the average concentration of respirable dust prescribed by section 202(b)(1) of the Act;

(f) "Average concentration of respirable dust" means the average concentration of respirable dust, expressed in milligrams per cubic meter of air, as measured by an MRE instrument or an equivalent concentration if measured with another device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare.

(g) "Working places" means those areas in a single working section which are at any given time inby the last open crosscut;

(h) "Working section" means all areas of the coal mine inby the loading point of the section to and including the working faces;

(i) "Qualified person" means a person who has satisfactorily completed a course in sampling and evaluation of respirable coal mine dust concentrations approved by the Secretary of the Interior with sampling devices approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare;

(j) "Certified engineer" means an engineer certified or registered by the State in which the coal mine is located to perform duties prescribed by title II of the Act, except that, in a State where no program of certification or registration is provided or where the program does not meet at least minimum Federal standards established by the Secretary of the Interior, such certification or registration shall be by the said Secretary;

(k) "Respirable dust level" means the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of the mine is exposed;

(l) "Engineering survey" means a determination by a certified engineer of the respirable dust levels of the working places of the mine with respect to which an application is filed together with a statement of the applicant's ability to reduce the dust levels therein.

#### § 501.3 Filing procedures.

(a) Applicants shall file an application on ICP Form 1 for each mine which shall include a Statement of Working Section Information on ICP Form 1(a) for the working places in each section for which a permit is requested. Except as provided in § 501.4(d), one copy of each form shall be filed on or before May 1, 1970, with the Interim Compliance Panel, Suite 800, 1730 K Street NW., Washington, D.C. 20006, in the form and content prescribed in § 501.4.

(b) The original of each ICP Form 1 shall be signed by the applicant and the original of each ICP Form 1(a) shall be signed by the applicant and by the certified engineer responsible for the engineering survey.

(c) At the time an application is mailed or delivered to the panel, the applicant shall post on the mine bulletin board a notice that such application has been filed and that the application and all related ICP Forms 1(a) are available at the mine office for inspection by any interested person during usual working hours. In addition, the applicant shall furnish a copy of the application to the union or other representative of the miners of the mine to which such application applies.

(d) A copy of each application and all related ICP Forms 1(a) received by the panel will be available at the office of the panel in Washington, D.C., for inspection by any person during usual working hours.

(e) Application forms may be obtained from Coal Mine Safety Offices of the U.S. Bureau of Mines or from the Interim Compliance Panel, Suite 800, 1730 K Street NW., Washington, D.C. 20006.

#### § 501.4 Contents of applications for permits.

(a) Each application for a permit (ICP Form 1) shall contain the name and address of the mine and the operator thereof and a list of working sections with respect to which such permit is requested, including any working section for which an ICP Form 1(a) can be completed on or before June 30, 1970.

(b) Each Statement of Working Section information (ICP Form 1(a)) shall contain a representation by the applicant and the certified engineer conducting the engineering survey as defined in § 501.2 (l) that the applicant is unable to comply with the respirable dust standard in those working places within each working section identified in the application:

(1) Because technology for reducing the respirable dust level at such places is not available; or

(2) Because of the lack or other effective control techniques or methods; or,

(3) Because of any combination of such reasons.

The representation shall be accompanied by an explanation of the reasons therefor.

(c) Each statement of working section information shall include the following:

(1) Identification of each working section in which are located the working places for which a permit is requested;

(2) The number of men regularly employed on each production shift and the usual number of production shifts per day;

(3) The type and method of mining, including haulage;

(4) The results of an engineering survey as defined in § 501.2 (l). The determination of respirable dust levels included in such a survey shall be made in accordance with the procedures set forth in this subparagraph (4)

(i) All measurements of respirable dust levels shall be conducted by a qualified person using an MRE instrument or other dust sampling device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare in accordance with the provisions of Part 74 of this title.

(ii) One sample of respirable dust shall be taken in each working section on the same production shift on each of 5 consecutive working days at the following locations:

* (*a*) Where conventional mining methods are employed, the sample shall be taken on the cutting machine operator or on the cutting machine within 36 inches by the operator's normal working position;

* (*b*) Where continuous mining methods are employed, the sample shall be taken on the continuous miner operator or on the continuous miner within 36 inches by the operator's normal working position;

(*c*) Where long wall mining methods are employed, samples shall be taken on the miner who works nearest the return air side of the long wall face or on the return-air side of the long wall face no farther than 48 inches from the corner;

(*d*) Where hand loading methods are employed, samples shall be taken on 10 percent of the hand loaders, but in no case less than one hand loader, or at a site which represents the average concentration of respirable dust to which all hand loaders are exposed;

(*e*) Where two or more mechanized mining operations are engaged in the production of coal in a single working section, each such mechanized mining operation shall be considered a separate working section. Samples of respirable dust shall be taken from each such mechanized mining operation in accordance with the provisions of this subparagraph.

(*f*) A sixth sample shall be taken in the intake air of each working section at a location within 200′ outby the working faces of the section within one working day of the completion of the sampling cycle required in this subparagraph.

(iii) Each sample of respirable dust taken in accordance with the provisions of subdivision (ii) of this subparagraph shall be weighed and the results found shall be converted and reported in accordance with the methods set forth in (*a*) and (*b*) of this subdivision.

(*a*) Approved sampling devices shall be operated at a flow rate of 2.0 liters of air per minute and the MRE instrument shall be operated at a flow rate of 2.5 liters of air per minute.

(*b*) The respirable dust level shall be determined by dividing the weight in milligrams of dust collected on the filter during a full production shift by the volume of air in cubic meters passing through the filter. To convert a concentration of respirable dust as measured with an approved sampling device to an equivalent concentration of respirable dust as measured with an MRE instrument, the concentration measured by the approved sampling device shall be multiplied by a constant factor of 1.6 and the product shall constitute the equivalent concentration as measured with an MRE instrument.

(5) A description of the ventilation system of the working section and its capacity;

(6) The quantity and velocity of air regularly reaching the working faces;

(7) The amount and pressure of water, if any, reaching the working faces;

(8) The number, location and type of sprays, if any;

(9) A description of any action taken to reduce the respirable dust level;

(10) A description by the applicant and the certified engineer who conducted the engineering survey under subparagraph (4) of this paragraph of the means and methods to be employed to achieve compliance with the respirable dust standard, the progress made to date, and an estimate of the date when compliance can be achieved.

(d) Where an applicant is unable to comply with all of the requirements set forth in this section with respect to any working place for which a permit for noncompliance has been requested, he shall specifically state the reasons for his failure to comply and indicate the date on which he expects to meet such requirements and complete his application.

(e) All applications timely filed in accordance with the provisions of this part shall be considered by the panel in the order in which completed applications are received and the panel shall make its determination on the basis of the evidence of record. Each applicant shall, however, upon written request by the panel, submit such additional evidence as the panel deems necessary to its determination, including, but not limited to, evidence in support of representations made under the provision of paragraph (b) of this section or evidence in support of claims that the survey required under the provisions of paragraph (c)(4) of this section cannot be completed on or before May 1, 1970.

### § 501.5 Issuance of initial permits.

(a) The panel will issue initial permits for working places within working sections based upon applications which are timely filed and complete in all material respects in accordance with §§ 501.3 and 501.4.

(b) No initial permit will be issued for working places in a working section that is not in existence on June 30, 1970.

(c) Each initial permit will be issued for the period specified by the panel but in no case for more than 1 year. Each permit will specify the average concentration of respirable dust which the applicant will be entitled to maintain, but in no case shall the level be greater than 4.5 mg/m$^3$.

(d) If a permit is issued, such permit will be forwarded to the applicant. If a permit is denied, the panel will advise the applicant in writing of the reasons therefor and give the applicant an opportunity for a public hearing.

(e) A copy of every permit for noncompliance shall be posted by the applicant in the manner and place prescribed by section 107(a) of the Act.

(f) No initial permit or renewal thereof shall be valid beyond June 30, 1971, or the date on which section 202(b)(1) is superseded by improved mandatory health standards, whichever first occurs.

### § 501.6 Applications for renewal permits.

(a) To be considered by the panel, every application for a renewal permit must be:

(1) Filed with the panel not more than 90 days, nor less than 30 days prior to the expiration date of a permit;

(2) Submitted on the forms and in the manner prescribed in §§ 501.3 and 501.4.

(b) When an application for a renewal of a permit for noncompliance is received, the panel shall cause to be published in the FEDERAL REGISTER a notice giving any interested person an opportunity to file with the panel a request for a public hearing.

(c) On or before the 15th day after publication of notice in the FEDERAL REGISTER that an application for renewal has been accepted for consideration, any interested person may file a request with the panel for a public hearing.

(d) Requests for hearing shall be submitted in triplicate to the panel, shall be in writing, and signed by the person making the request.

(e) A request for hearing shall be accepted only if:

(1) It states the interest in the application of the person making the request;

(2) It alleges specific facts which raise a substantial issue and, if established at the hearing, would result in the denial or modification of the permit.

(f) If the request for hearing is denied, the panel shall inform the person making the request in writing of the reasons therefor.

(g) If the request for hearing is granted, the panel shall publish in the FEDERAL REGISTER a notice of hearing which sets forth the date, time and place of such hearing. Notice of such hearing will be mailed to the person requesting the hearing. Notice of hearing will also be mailed to the applicant at his last known address together with a copy of the request for hearing.

(h) After public hearing, or if no hearing has been requested pursuant to paragraph (c) of this section, the panel shall make its determination.

### § 501.7 Request for hearing on renewal permit by applicant.

(a) Where the panel has not received a timely and sufficient request for hearing by an interested person and has reason to believe that it will deny a renewal permit on the basis of the evidence of record, it will, prior to the denial of such permit, give notice in writing, to the applicant, of its intention to deny the permit, the reasons therefor, and an opportunity to request a public hearing.

(b) On or before the 15th day after such notice, the applicant may file a request with the panel for a public hearing.

(c) Requests for hearing shall be submitted in triplicate to the panel, shall be in writing, and signed by the applicant.

(d) A request for hearing shall be accepted only if it contains allegations which, if established, would result in the issuance of the renewal permit at a respirable dust level greater than that shown in the application to be possible.

[F.R. Doc. 70-3980; Filed, Mar. 30, 1970; 10:23 a.m.]

*Change the word "by" to "inby".

# APPENDIX B.--INTERIM COMPLIANCE PANEL FORMS

## Directions for Filling Out Interim Compliance Panel Forms, ICP Form 1 and 1(a)

1. Use typewriter or ball-point pen to fill out the application forms. If done by hand, print, except for signature.

2. Submit the original and one copy of ICP Form 1, signed by the operator or his authorized representative. Form ICP 1 needs to be made out once for each mine each time an application for noncompliance is submitted.

3. Submit the original and one copy of ICP Form 1(a) for each working section for which a permit for noncompliance is being requested. Each of these is to be signed by a certified engineer and by the operator or his authorized representative.

4. If additional space is needed for explanation or for plans, use extra sheets (original plus one copy).

5. Regarding Part F "Dust Samples," comply with all parts of ICP Regulation Section 501.4(c)(4). Sample locations are:

   A. Intake air--one sample--within 200' outby the working faces of the section.

   B. Conventional Mining: All samples shall be taken on the operator of the cutting machine or on the cutting machine within 36" inby the operator's normal working position.

   C. Continuous Mining: All samples taken on the operator of the continuous miner or on the continuous mining machine within 36" inby the operator's normal working position.

   D. Long Wall Mining: Samples taken on miner who works nearest return air side of the long wall face or at a site located in the return air current no farther than 48" from the corner of the return side on the long wall face.

   E. Hand loading: Sample 10% of hand loaders but in no case less than one, or locate at site of maximum concentration of dust in which the miners work.

   F. If two or more mechanized units are used in a working section, sample each unit as in B and C, above.

6. If approved personal samplers are used for dust survey, multiply results by 1.60 to convert to the MRE equivalent.

7. Additional copies of the application forms (ICP Form 1 and ICP Form 1(a)) may be obtained from the Interim Compliance Panel, 1730 K Street, N.W., Washington, D.C. 20006, or from the U.S. Bureau of Mines Coal Mine Safety District and Subdistrict offices.

ICP FORM NO. 1

Budget Bureau No. 152-R0001 Approval Expires 6-30-71

For ICP use only

# INTERIM COMPLIANCE PANEL
# APPLICATION
# FOR A PERMIT FOR NONCOMPLIANCE

with Interim Mandatory Health Standards
Federal Coal Mine Health and Safety Act of 1969

SEND ORIGINAL AND ONE COPY TO ICP.

Check: Application is for

☐ Initial Permit ☐ Renewal of Permit

A. NAME OF MINE OWNER

ADDRESS

CITY COUNTY STATE ZIP

AUTHORIZED REPRESENTATIVE TELEPHONE NO.

B. NAME OF MINE USBM ID #

ADDRESS

CITY COUNTY STATE ZIP

NAME OF OPERATOR TELEPHONE NO.

C. Date when notice of this application was posted on the mine bulletin board. DATE

D. Request for a permit for noncompliance with the Interim Mandatory Health Standards is made for the working places in the following working section(s): (Attach a separate description for each section listed on forms provided and in the manner specified.)

| Identification of working section (to relate to mine map) | Bureau of Mines Section Identification Number | Estimated life of Section from 7/1/70 (months) |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |
| 11. | | |
| 12. | | |

SIGNATURE OF MINE OPERATOR OR HIS AUTHORIZED REPRESENTATIVE DATE

ICP FORM NO. 1(a)

Budget Bureau Number: 152-R0001 Approval Expires 6-30-71

For ICP use only

INTERIM COMPLIANCE PANEL
WORKING SECTION INFORMATION

The following information is provided as a basis for the request for a PERMIT FOR NONCOMPLIANCE for the working section identified below.

A. REASON FOR THIS REQUEST (See 202(c)(1) P.L. 91-173)

(Check appropriate reasons listed below and explain on separate sheet)

1. Technology for reducing the concentration of respirable dust to the interim mandatory standard is not available. ☐
2. Lack of other effective control techniques. ☐
3. Any combination of such reasons. ☐

B. 1. Name of Mine                                    USBM ID No.

2. Working Section                                    USBM ID No.

3. Number of men regularly employed per production shift.    4. Number of production shifts per day.

| C. Mining Practice | Conventional | Continuous | Longwall | Hand Loading | Other (Specify) |
|---|---|---|---|---|---|
| Developing | | | | | |
| Retreating | | | | | |

| Haulage | Tractor | Shuttle Car | Belt Conveyor | Chain Conveyor | Track | Other (Specify) |
|---|---|---|---|---|---|---|
| Face | | | | | | |
| Secondary | | | | | | |
| Main | | | | | | |
| Other (Specify) | | | | | | |

D. 1. Section Ventilation                                    Total Air Quantity (cfm)

Number of Entries: Intake:__________    Entering Section__________    In last open crosscut__________

Return:__________

| Stoppings | Metal | Block | Wood | Plastic | Cloth | Other (Specify) |
|---|---|---|---|---|---|---|
| Permanent | | | | | | |
| Temporary | | | | | | |

2. Face Ventilation: Entry Size

Height__________

Width __________

Air at Face

Velocity (fpm) __________

Quantity (cfm) __________

Direction: Exhausting ☐ Blowing ☐

Additional face ventilation practices: (Specify and describe)__________

Initial ☐
Renewal ☐

For ICP use only

# INTERIM COMPLIANCE PANEL

## E. OTHER DUST CONTROL PRACTICES

1. Water ☐ 2. Other (Specify) ☐

Describe practice(s) checked above (use additional sheets as needed)

## F. ENGINEERING SURVEY (Provide the results of six dust samples obtained in the manner and with the equipment prescribed by ICP Regulations 501.4(c)(4)).

1. Equipment Used (give manufacturer's name and equipment number)
   a. Pump Assembly ________
   b. Sampling Head ________

Include statement of Applicant's Ability to reduce the dust levels therein.

2. Sample Results

| Sampling Date | Sample Location* | mgm/m³ |
|---|---|---|
| 1 | Intake | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

Average dust concentration (do not include intake air) ________ mgm/m³

*Sample location: (see instructions) INTAKE AIR: within 200′ outby working faces. CONVENTIONAL MINING: on cutting machine or on operator of CM. CONTINUOUS MINING: on continuous miner or on operator of CMM. LONGWALL MINING: on miner working nearest return air side or on adjacent wall of return air side of the longwall face. HAND LOADING: on 10% but not less than one hand loader or located at site of maximum dust concentration where miners will work.

For ICP use only

Initial ☐
Renewal ☐

# INTERIM COMPLIANCE PANEL

G. Plans to Achieve Compliance (Describe—Include methods and equipment to be used, the estimated date that compliance will be accomplished and attach copies of orders for equipment, if any, including estimated dates of delivery.)

H. I have reviewed the foregoing information and certify that it is true and correct to the best of my knowledge.

(Signature) ______________________________
Operator or his authorized representative

Engineer's Seal and Certificate No. (Signature) ______________________________
Certified Engineer

______________________________
Engineer's Address

______________________________
City County State

______________________________ Zip Code __________
Engineer's Phone No.

Anyone who makes any false statement in this application is subject to the penalties provided in Section 109(d) Federal Coal Mine Health and Safety Act of 1969, P.L. 91-173.

# Title 30—MINERAL RESOURCES

## Chapter I—Bureau of Mines, Department of the Interior

### SUBCHAPTER O—COAL MINE HEALTH AND SAFETY

### PART 74—COAL MINE DUST PERSONAL SAMPLER UNITS

Section 202(a) of the Federal Coal Mine Health and Safety Act of 1969 provides for the taking of samples of the respirable dust in coal mine atmospheres by a device approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare. Accordingly, Part 74, reading as set forth below, is added to Subchapter O of Chapter I, Title 30, Code of Federal Regulations. This part sets forth the requirements which must be met by approved coal mine dust personal sampler units. It is important that sampler units meeting these requirements be produced as quickly as possible. Therefore, it would not be in the public interest either to give notice of proposed rulemaking on, or to delay the effective date of, Part 74. Accordingly, Part 74 shall become effective upon its publication in the FEDERAL REGISTER.

WALTER J. HICKEL,
*Secretary of the Interior.*

ROBERT H. FINCH,
*Secretary of Health, Education, and Welfare.*

MARCH 6, 1970.



AUTHORITY: The provisions of this Part 74 issued under sec. 508, Federal Coal Mine Health and Safety Act of 1969 (83 Stat. 803).

### § 74.1 Purpose.

The regulations in this part set forth the requirements for approval of coal mine dust personal sampler units designed to determine the concentrations of respirable dust in coal mine atmospheres; procedures for applying for such approval; test procedures; and labeling.

### § 74.2 Sampler unit.

A coal mine dust personal sampler unit shall consist of (a) a pump unit, (b) a sampling head assembly, and (c) if rechargeable batteries are used in the pump unit, a battery charger.

### § 74.3 Specifications of sampler unit.

(a) *Pump unit*—(1) *Dimensions*. The overall dimensions of the pump unit, hose connections and valve or switch covers shall not exceed 8 inches in height, 6 inches in width and 4 inches in thickness.

(2) *Weight*. The pump unit shall not weigh more than 4 pounds.

(3) *Construction*. The case and all components of the pump unit shall be of sufficiently durable construction to endure the wear of use in a coal mine and shall be tight fitting, so as to minimize the amount of dust entering the pump case.

(4) *Exhaust*. The pump shall exhaust into the pump case, maintaining a slight positive pressure which will reduce the entry of dust into the pump case.

(5) *Switch*. The pump unit shall be equipped with an on-off switch or equivalent device on the outside of the pump case. This switch shall be protected against accidental operation during use and protected to keep dust from entering the mechanisms.

(6) *Flow rate adjustment*. Except as provided in the last sentence of this subparagraph, the pump unit shall be equipped with a suitable means of flow rate adjustment accessible from outside the case. To prevent accidental adjustment, the flow rate adjuster shall be recessed in the pump case and shall require the use of an adjusting tool. If the pump is capable of maintaining the flow rate consistency required in this part without adjustment, an external flow rate adjuster is not required.

(7) *Battery*. The power supply for the pump shall be a suitable battery located in the pump case or in a separate case which attaches to the pump case by a permissible electrical connection.

(8) *Pulsation*. The irregularity in flow rate due to pulsation shall have a fundamental frequency of not less than 20 Hz.

(9) *Belt clips*. The pump unit shall be provided with a belt clip which will hold the pump securely on a coal miner's belt.

(10) *Recharging connection*. A suitable connection shall be provided so that the battery may be recharged without removing the battery from the pump case or from the battery case if a separate battery case is used.

(11) *Flow rate indicator*. A visual indicator of flow rate (e.g., a flowmeter) shall be provided either as an integral part of the pump unit or of the sampling head assembly. The flowrate indicator shall be calibrated within ±5 percent at 2, 1.8, and 1.6 liters per minute to indicate the rate of air passing through the accompanying sampling head assembly.

(12) *Flow rate range*. The pump shall be capable of operating in or over a range of from 1.5 to 2.5 liters per minute and shall be adjustable over this range.

(13) *Flow rate consistency*. The flow shall remain within ±0.1 liters per minute over an 8-hour period when the pump is operated at 2 liters per minute with a standard sampling head assembly. Not more than two readjustments of the flow rate to 2 liters per minute shall be required to maintain this accuracy.

(14) *Duration of operation*. The pump shall be capable of operating for not less than 8 hours at a flow rate of 2 liters per minute against a resistance of 4 inches of water measured at the inlet of the pump.

(b) *Sampling head assembly*. The sampling head assembly shall consist of a cyclone and a filter assembly as follows:

(1) *Cyclone*. The cyclone shall consist of a cyclone body with removable grit cap and a vortex finder and shall be constructed of nylon or a material equivalent in performance. The dimensions of the components, with the exception of the grit cap, shall be identical to those of a Dorr-Oliver 10 mm. cyclone body, part No. 28541/4A or 01B11476-01 and vortex finder, part No. 28541/4B.

(2) *Filter assembly*. The filter assembly shall meet the following requirements:

(i) *Filter*. The filter shall be a membrane filter type with a nominal pore size not over 5 microns. It shall be nonhydroscopic and shall not dissolve or decompose when emersed in ethyl or isopropyl alcohol. The strength and surface characteristics of the filter shall be such that dust deposited on its surface may be removed by ultrasonic methods without tearing the filter. The filter resistance shall not be more than 2 inches of water at an airflow rate of 2 liters per minute.

(ii) *Capsule*. The capsule enclosing the filter shall not permit sample air to leak around the filter. The capsule shall be made of nonhydroscopic material. Its weight, including the enclosed filter, shall not exceed 5 grams and it shall be preweighed by the manufacturer with a precision of ±0.1 milligrams. Impact to the capsule shall not dislodge any dust from the capsule, which might then be lost to the weight measurement.

(iii) *Cassette*. The cassette shall enclose the capsule so as to prevent contamination. The cassette must be easily removable without causing a loss or gain of capsule weight. Appropriate covers shall be provided to prevent contaminants from entering, or dust from leaving, the capsule when it is not in use.

(3) *Arrangement of components*. The connections between the cyclone vortex finder and the capsule and between the capsule and the ¼-inch (inside diameter) hose mentioned in subparagraph (5) of this paragraph shall be mechanically firm and shall not leak at a rate of more than 0.1 liters per hour under a vacuum of 4 inches of water.

(4) *Clamping of components.* The clamping and positioning of the cyclone body, vortex finder, and cassette shall be rigid, remain in alignment, be firmly in contact and airtight. The cyclone-cassette assembly shall be attached firmly to a backing plate or other means of holding the sampling head in position. The cyclone shall be held in position so that the inlet opening of the cyclone is pointing perpendicular to, and away from, the backing plate.

(5) *Hose.* A 3-foot long, ¼-inch (inside diameter) hose shall be provided to form an airtight connection between the inlet of the sampler pump and the outlet of the filter assembly. A device, capable of sliding along the hose and attaching to the miner's outer garment shall be provided.

(c) *Battery charger*—(1) *Power supply.* The battery charger shall be operated from a 117 volt, 60 Hz power line.

(2) *Connection.* The battery charger shall be provided with a cord and polarized connector so that it may be connected to the charge socket on the pump or battery case.

(3) *Protection.* The battery charger shall be fused, shall have a grounded power plug, and shall not be susceptible to damage by being operated without a battery on charge.

(4) *Charge rates.* The battery charger shall be capable of operating at either a 16-hour or a 64-hour charge rate. The battery charger shall be capable of fully charging the battery in the pump unit in the stated times and shall not overcharge a discharged battery in 16 hours when operating at the 16-hour charge rate or in 88 hours when operating at the 64-hour charge rate.

**§ 74.4 Tests of coal mine dust personal sampler units.**

(a) The Bureau of Occupational Safety and Health, Department of Health, Education, and Welfare, shall conduct tests to determine whether a coal mine dust personal sampler unit which is submitted for approval under these regulations meets the requirements set forth in § 74.3.

(b) The Bureau of Mines, Department of the Interior, will conduct tests, pursuant to § 18.68 of this chapter, to determine whether the pump unit of a coal mine dust personal sampler unit submitted for approval under these regulations is intrinsically safe.

**§ 74.5 Conduct of tests; demonstrations.**

Prior to the issuance of a certificate of approval, only personnel of the Bureau of Mines and Bureau of Occupational Safety and Health, representatives of the applicant, and such other persons as may be mutually agreed upon may observe the tests conducted. The Bureau of Mines and the Bureau of Occupational Safety and Health shall hold as confidential, and shall not disclose, principles of patentable features prior to certification, nor shall the bureaus disclose any details of the applicant's drawings or specifications or other related material. After the issuance of a certificate of approval, the Bureau of Mines or the Bureau of Occupational Safety and Health may conduct such public demonstrations and tests of the approved coal mine dust personal sampler unit as the bureau deems appropriate. The conduct of all investigations, tests, and demonstrations shall be under the sole direction of the Bureau of Occupational Safety and Health and the Bureau of Mines and any other persons shall be present only as observers.

**§ 74.6 Applications.**

(a) Testing of a coal mine dust personal sampler unit will be undertaken by the Bureau of Occupational Safety and Health, and testing of the pump unit of such a sampler unit will be undertaken by the Bureau of Mines, only pursuant to a written application in duplicate, each copy accompanied by complete scale drawings, specifications and description of materials. An application to the Bureau of Mines must be accompanied by a check, bank draft, or money order in the amount of $105, payable to the U.S. Bureau of Mines, to cover the fee specified in § 18.7 of this chapter. The applications, together with the drawings and specifications and any other related documents shall be sent to Bureau of Occupational Safety and Health, Department of Health, Education and Welfare, 1014 Broadway, Cincinnati, Ohio 45202, and to the Bureau of Mines, Department of the Interior, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.

(b) Ten complete coal mine dust personal sampler units must be sent to the Bureau of Occupational Safety and Health in connection with an application. One pump unit must be sent to the Bureau of Mines in connection with an application.

(c) Drawings and specifications shall be adequate in number and fully detailed to identify the design of the coal mine dust personal sampler unit or pump unit thereof and to disclose the dimensions and materials of all component parts.

(d) An application shall describe the way in which each lot of components will be sampled and tested to maintain their quality prior to assembly of each sampler unit. In order to ensure that the quality of the coal dust personal sampler unit will be maintained in production through adequate quality control procedures, the Bureau of Occupational Safety and Health and the Bureau of Mines reserve the right to have their qualified personnel inspect each applicant's control-test equipment procedures, and records and to interview the employees who conduct the control tests. Two copies of the results of any tests made by the applicant on the coal mine dust personal sampler unit or the pump unit thereof shall accompany an application.

**§ 74.7 Certificate of approval.**

(a) Upon completion of the testing of a coal mine dust personal sampler unit or the pump unit thereof, the Bureau of Occupational Safety and Health or the Bureau of Mines, as appropriate, shall issue to the applicant either a certificate of approval or a written notice of disapproval, as the case may require. The Bureau of Occupational Safety and Health shall not issue a certificate of approval for a coal mine dust personal sampler unit unless the Bureau of Mines has issued a certificate of approval for the pump unit thereof. No informal notification of approval will be issued. If a certificate of approval is issued, no test data or detailed results of tests will accompany such approval. If a notice of disapproval is issued, it will be accompanied by details of the defects, resulting in disapproval, with a view to possible correction.

(b) A certificate of approval will be accompanied by a list of the drawings and specifications, covering the details of design and construction of the coal mine dust personal sampler unit or the pump unit thereof upon which the certificate of approval is based. The applicant shall keep exact duplicates of the drawings and specifications submitted to the Bureau of Occupational Safety and Health and to the Bureau of Mines relating to the sampler unit or pump unit thereof which has received a certificate of approval. The approved drawings and specifications shall be adhered to exactly in the production of the certified sampler unit, including the pump unit thereof, for commercial purposes. In addition, the applicant shall observe such procedures for, and keep such records of, the control of component parts as either bureau may in writing require as a condition of certification.

**§ 74.8 Approval labels.**

(a) Certificates of approval will be accompanied by photographs of designs for the approval labels to be affixed to each coal mine dust personal sampler unit.

(b) The labels showing approval by the Bureau of Occupational Safety and Health and by the Bureau of Mines shall contain such information as the appropriate bureau may require and shall be reproduced legibly on the outside of a sampler unit as directed by the appropriate bureau.

(c) The applicant shall submit full-scale designs or reproductions of approval labels and a sketch or description

of the position of the labels on each unit.

(d) Use of the approval labels obligates the applicant to whom the certificates of approval were issued to maintain the quality of the complete coal mine dust personal sampler unit and to guarantee that the complete sampler unit is manufactured or assembled according to the drawings and specifications upon which the certificates of approval were based. Use of the approval labels is authorized only on sampler units which conform strictly with the drawings and specifications upon which the certificates of approval were based.

§ 74.9 Material required for record.

(a) As part of the permanent record of the investigation, the Bureau of Occupational Safety and Health will retain a complete coal mine dust personal sampler unit, and the Bureau of Mines will retain a pump unit, that has been tested and certified. Material not required for record purposes will be returned to the applicant at his request and at his expense on written shipping instructions to the appropriate bureau.

(b) As soon as a coal mine dust personal sampler unit is commercially available, the applicant shall deliver a complete unit free of charge to the Bureau of Occupational Safety and Health, Department of Health, Education, and Welfare, 1014 Broadway, Cincinnati, Ohio 45202.

§ 74.10 Changes after certification.

(a) If the applicant desires to change any feature of a certified coal mine dust personal sampler unit, he shall first obtain the approval of the Bureau of Occupational Safety and Health pursuant to the following procedures:

(1) Application shall be made as for an original certificate of approval, requesting that the existing certification be extended to encompass the proposed change. The application shall be accompanied by drawings, specifications and related material, as in the case of an original application.

(2) The application and accompanying material will be examined by the Bureau of Occupational Safety and Health to determine whether testing of the modified sampler unit or components will be required. Testing will be necessary if there is a possibility that the modification may affect the performance of the sampler unit adversely. The Bureau of Occupational Safety and Health will inform the applicant whether such testing is required.

(3) If the proposed modification meets the pertinent requirements of these regulations, a formal extension of certification will be issued, accompanied by a list of new and revised drawings and specifications to be added to those already on file as the basis for the extension of certification.

(b) If a change is proposed in a pump unit of a certified coal dust personal sampler unit, the approval of the Bureau of Mines with respect to intrinsic safety shall be obtained in accordance with the procedures set forth in paragraph (a) of this section.

§ 74.11 Withdrawal of certification.

The Bureau of Occupational Safety and Health or the Bureau of Mines may rescind, for cause, any certificate of approval which the respective bureau has issued under the regulations in this part.

[F.R. Doc. 70-2968; Filed, Mar. 10, 1970; 8:49 a.m.]

# Title 30—MINERAL RESOURCES

## Chapter I—Bureau of Mines, Department of the Interior

### SUBPART O—COAL MINE HEALTH AND SAFETY

### PART 70—MANDATORY HEALTH STANDARDS — UNDERGROUND COAL MINES

Part 70, reading as set forth below, is added to Subchapter O of Chapter 1, Title 30, Code of Federal Regulations. In addition to provisions relating to sampling respirable dust in coal mine atmospheres, this part sets out certain mandatory health standards contained in title II of the Federal Coal Mine Health and Safety Act of 1969, interpretations thereof, and statements with respect to respiratory equipment approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare. It is impracticable to give notice of proposed rulemaking with respect to the provisions relating to sampling respirable dust because of the limitations of time imposed by section 202(a) of the Act in this regard.

Part 70 shall become effective on June 30, 1970.

WALTER J. HICKEL,
*Secretary of the Interior.*

ROBERT H. FINCH,
*Secretary of Health, Education, and Welfare.*

APRIL 1, 1970.



AUTHORITY: The provisions of this Part 70 issued under title II, and sec. 508 of the Federal Coal Mine Health and Safety Act of 1969 (83 Stat. 742).

## Subpart A—General

### § 70.1 Scope.

This Part 70 sets forth health standards compliance with which is mandatory in each underground coal mine subject to the Federal Coal Mine Health and Safety Act of 1969. Regulations supplementary to these standards also are set forth in this part.

### § 70.2 Definitions.

For the purpose of this Part 70, the term—

(a) "Certified" or "registered" as applied to any person means a person certified or registered by the State in which the coal mine is located to perform duties prescribed by such titles, except that, in a State where no program of certification or registration is provided or where the program does not meet at least minimum Federal standards established by the Secretary, such certification or registration shall be by the Secretary;

(b) "Qualified person" means, as the context requires, an individual deemed qualified by the Secretary and designated by the operator to make tests and examinations required by this Act; and

(c) "Permissible" as applied to equipment used in the operation of a coal mine, means equipment, other than permissible electric face equipment, to which an approval plate, label, or other device is attached as authorized by the Secretary for the construction and maintenance of such equipment and are designed to assure that such equipment will not cause a mine explosion or a mine fire;

(d) "Working face" means any place in a coal mine in which work of extracting coal from its natural deposit in the

earth is performed during the mining cycle;

(e) "Working place" means the area of a coal mine inby the last open crosscut;

(f) "Working section" means all areas of the coal mine from the loading point of the section to and including the working face; when two or more mechanized mining sections (as defined in § 75.319–1 of Part 75, Subchapter O this chapter) are engaged in the production of coal within the same working section, each such mechanized mining section shall be considered a separate "working section" for the purpose of this Part 70;

(g) "Active workings" means any place in a coal mine where miners are normally required to work or travel;

(h) "Normal production shift" (as differentiated from a maintenance shift) means a shift during which the amount of coal produced in a working section is representative of the average amount of coal produced in such working section during all production shifts worked during the life of such working section or during the 6 months immediately preceding such production, whichever is the shorter period. With regard to a new working section, a "normal production shift" means a shift during which the amount of coal produced is comparable to the amounts produced during "normal production shifts" in other comparable working sections.

(i) "Respirable dust" means only dust particulates 5 microns or less in size;

(j) "Coal mine" includes areas of adjoining mines connected underground;

(k) "Secretary" means the Secretary of the Interior or his delegate;

(l) "Act" means the Federal Coal Mine Health and Safety Act of 1969;

(m) "Concentrations of respirable dust" means the average concentration of respirable dust if measured with an MRE instrument or such equivalent concentrations if measured with another device approved by the Secretary and the Secretary of Health, Education, and Welfare;

(n) "MRE instrument" means the gravimetric dust sampler with four channel horizontal elutriator developed by the Mining Research Establishment of the National Coal Board, London, England; and

(o) "Average concentration" means a determination which accurately represents the atmospheric conditions with regard to respirable dust to which each miner in the active working of a mine is exposed (1) as measured, during the period ending June 30, 1971, over a number of continuous production shifts to be determined by the Secretary and the Secretary of Health, Education, and Welfare and (2) as measured thereafter, over a single shift only, unless the Secretary and the Secretary of Health, Education, and Welfare find, in accordance with the provisions of § 101 of the Act, that such single shift measurement will not, after applying valid statistical techniques to such measurement, accurately represent such atmospheric conditions during such shift.

## Subpart B—Dust Standards

### § 70.100 Dust standards; respirable dust.

(a) Effective June 30, 1970, each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of such mine is exposed at or below 3.0 milligrams of respirable dust per cubic meter of air.

(b) Effective December 30, 1972, each operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of such mine is exposed at or below 2.0 milligrams of respirable dust per cubic meter of air.

(c) An operator need not comply with paragraph (a) or paragraph (b) of this section during the period of time specified in a permit of noncompliance issued by the Interim Compliance Panel established by the Act, but during that period the operator shall continuously maintain the average concentration of respirable dust in the mine atmosphere during each shift to which each miner in the active workings of the mine is exposed at or below the limit specified in the permit of noncompliance.

## Subpart C—Sampling Procedures

### § 70.201 Sampling; general requirement.

Each operator of a coal mine shall, as prescribed in this Part 70, take accurate samples of the amount of respirable dust in the mine atmosphere to which each miner in the active workings of such mine is exposed.

### § 70.202 Sampling; by whom done.

The dust sampling required by this Part 70 shall be done by, or as directed by, a person—

(a) Who has had practical experience in an underground coal mine;

(b) Who has a working knowledge of the mining equipment employed in the mine in which samples are taken;

(c) Who has a working knowledge of the coal mine ventilation system in the mine in which samples are taken;

(d) Who has a working knowledge of the operation and care of the sampling devices mentioned in § 70.203 and the filters employed in such devices; and

(e) Who has satisfactorily completed a course approved by the Secretary in sampling and evaluation of respirable coal mine dust concentrations with the sampling devices mentioned in § 70.203.

### § 70.203 Approved sampling devices.

Except as provided in § 70.204, the samples which this Part 70 requires to be taken shall be taken only with a coal mine dust personal sampler unit approved under Part 74 of this chapter or with an MRE instrument.

### § 70.204 Approved sampling devices; existing coal mine dust personal sampler units.

(a) Coal mine dust personal sampler units in use on or before June 30, 1970, which contain any combination of the pumps, sampling head assemblies and battery chargers listed in paragraphs (b), (c), and (d) of this section may be used until January 1, 1971, to take samples of respirable dust as required by this Part 70.

(b) The following battery operated pump units approved by the Bureau of Mines for intrinsic safety under the provisions of Part 18 of this chapter (Bureau of Mines Schedule 2F and 2G):

(1) Cassella, Ltd., Willson Products Division, Post Office Box 622, Reading, Pa. 19603: Mark II, Model B;

(2) Mine Safety Appliances Co., 201 North Braddock Avenue, Pittsburgh, Pa. 15208: Model G;

(3) UNICO Environmental Instruments, Inc., 150 Cove Street, Fall River, Mass. 02720: Model C110.

(c) The following sampling head assemblies:

(1) Mine Safety Appliances Co., 201 North Braddock Avenue, Pittsburgh, Pa. 15208: Gravimetric Dust Sampler;

(2) UNICO Environmental Instruments, Inc., 150 Cove Street, Fall River, Mass. 02720: Respirable Mass Lapel Sampler;

(3) Any other sampling head assembly employing the following components:

(i) A Dorr-Oliver nylon cyclone, a nylon vortex finder and a grit cap, as specified in subparagraph (1), paragraph (b) of § 74.3 of Part 74 of this chapter;

(ii) A filter assembly, as specified in subparagraph (2), paragraph (b) of § 74.3 of Part 74 of this chapter, except the filter assembly need not meet the preweight specification prescribed in that subparagraph.

(d) A battery charger designated as appropriate by the manufacturer of the pump unit employed in the particular coal mine dust sampler unit.

### § 70.205 Approved sampling devices; operation, rates of air flow.

An approved coal mine dust personal sampler unit shall be operated at a flow rate of 2.0 liters of air per minute. An MRE instrument shall be operated at a flow rate of 2.5 liters of air per minute.

### § 70.206 Approved sampling devices; equivalent concentrations.

The concentration of respirable dust expressed in milligrams per cubic meter of air shall be determined by dividing the weight of dust in milligrams collected on the filter by the volume of air in cubic meters passing through the filter. To convert a concentration of respirable dust as measured with an approved coal mine dust personal sampler unit to an equivalent concentration of respirable dust as measured with an MRE instrument, the concentration of respirable dust measured with an approved coal mine dust personal sampler unit shall be multiplied

by a constant factor of 1.6 and the product shall be the equivalent concentration as measured with an MRE instrument.

### Original Determination of Respirable Dust Concentration

**§ 70.210 Original sampling cycle; establishment of basic sample.**

(a) Samples of respirable dust with respect to each working section of a coal mine shall be taken on 10 consecutive normal production shifts, each of which is worked on a separate calendar day, beginning with a normal production shift completed on or after June 30, 1970, except that, with respect to working sections located in multisection mines, original sampling may be conducted in accordance with the provisions of § 70.241 of this part. An original sampling cycle shall be begun with respect to each working section of a coal mine no later than the 11th day upon which normal production shifts are worked in that section. For each working section, this series of 10 samples, or a series of 10 samples submitted in accordance with the provisions of § 70.230 of this part, shall constitute the basic sample with respect to that working section.

(b) Where a working section is opened after June 30, 1970, the original sampling cycle required in accordance with the provisions of paragraph (a) of this section shall be begun on a normal production shift (as defined in § 70.220) on the first production day in such working section and thereafter on consecutive production shifts (as defined in § 70.220).

**§ 70.211 Violation of dust standard; original sampling cycle.**

(a) If the data recorded pursuant to § 70.261 for an original sampling cycle with respect to a working section of a coal mine establish a cumulative concentration of respirable dust in excess of the cumulative concentration stated in paragraph (b) of this section with respect to the particular applicable limit, without regard to the number of samples analyzed, the Secretary shall issue a notice to the operator that he is in violation of paragraph (a) or paragraph (c) of § 70.100 of this Part 70. Paragraph (a) of § 70.100 prescribes a limit of 3.0 milligrams of respirable dust per cubic meter of air. Paragraph (c) of § 70.100 covers permits for noncompliance issued by the Interim Compliance Panel established by the Act. Such a permit may establish a limit of 4.5 milligrams, 4.0 milligrams, or 3.5 milligrams.

(b) The cumulative concentration of respirable dust recorded from samples which establish noncompliance with a particular applicable limit may be as follows:

(1) If, when a limit of 4.5 milligrams per cubic meter of air is in effect, the cumulative concentration exceeds 45 milligrams of respirable dust per cubic meter of air;

(2) If, when a limit of 4.0 milligrams per cubic meter of air is in effect, the cumulative concentration exceeds 40 milligrams of respirable dust per cubic meter of air;

(3) If, when a limit of 3.5 milligrams per cubic meter of air is in effect, the cumulative concentration exceeds 35 milligrams of respirable dust per cubic meter of air;

(4) If, when a limit of 3.0 milligrams per cubic meter of air is in effect, the cumulative concentration exceeds 30 milligrams of respirable dust per cubic meter of air.

(5) If, when any limit, other than those stated in subparagraphs (1), (2), (3), and (4) of this paragraph, is in effect under a permit for noncompliance, the cumulative concentration exceeds 10 times the specified limit of respirable dust per cubic meter of air.

### Standard Sampling Cycle

**§ 70.220 Standard sampling cycle.**

(a) (1) Except as provided in subparagraph (2) of this paragraph, during the calendar month beginning on the day the operator receives notice that a working section of a coal mine is in compliance, samples of respirable dust with respect to that working section shall be taken each calendar month thereafter during five consecutive normal production shifts, each of which is worked on a separate calendar day.

(2) In order to ensure that the procedures and methods for sampling set forth in this part result in the transmission of an adequate number of reliable samples, the Secretary, with the concurrence of the Secretary of Health, Education, and Welfare, may require any operator of a coal mine to sample at more frequent intervals than are prescribed in subparagraph (1) of this paragraph.

(3) Upon the issuance of a notice of violation of paragraph (a) or (c) of § 70.100 of this part with respect to any working section of a coal mine, paragraph (a) of this section shall not apply in respect of that working section until the violation is abated, and the operator shall take samples with respect to that working section during each production shift as required by § 104(i) of the Act.

(4) Upon receipt of a notice of the abatement of a violation with respect to a working section for which a notice of violation has been issued in accordance with the provisions of § 104(i) of the Act, or upon receipt of a notice of modification of a permit for noncompliance establishing a new dust standard, or upon the expiration of a permit for noncompliance, the operator shall initiate (in accordance with provisions of § 70.210) an original sampling cycle on the first day following receipt of such notice or such expiration on which there is a normal production shift.

(b) For the purpose of this Subpart C:

(1) "normal production shift" (as differentiated from a maintenance shift) means a shift during which the amount of coal produced in a working section is representative of the average amount of coal produced in such working section during all production shifts worked during the life of such working section or during the six months immediately preceding such production, whichever is the shorter period. With regard to a new working section, a "normal production shift" means a shift during which the amount of coal produced is comparable to the amounts produced during normal production shifts in other comparable working sections.

(2) A production shift during a calendar day (for example, the day shift on June 4) following a production shift during an earlier calendar day (for example, the afternoon shift on June 1) shall be considered consecutive production shifts even though a nonproducing calendar day or days (June 2 and June 3) may have intervened.

(3) The calendar month with respect to any working section for which a basic sample has been established pursuant to § 70.210 shall begin on the day upon which the operator receives notice from the Secretary that the working section is in compliance.

(4) A calendar month (regardless of whether the month or months of the calendar involved have 28, 29, 30, or 31 days) is a period terminating with the day of the succeeding month (of the calendar) numerically corresponding to the day (date) of its beginning, less one, except, if there be no corresponding day of the succeeding month, the period terminates with the last day of the succeeding month. (For example, if the calendar month begins on July 20, it ends on August 19 of the same year and on the 19th day of each succeeding month.)

**§ 70.221 Daily determination of average respirable dust concentrations; notice of violation.**

(a) Each sample transmitted by an operator with respect to a working section from the standard sampling cycle shall be combined with the 10 samples taken in such working section during the original sampling cycle. After combining these 11 samples, the first sample transmitted during the original sampling cycle shall be discarded. The remaining 10 samples will then constitute a current basic sample with respect to that working section and a daily determination of compliance or noncompliance shall be made on the basis of the data recorded from the 10 samples contained in the current basic sample. Thereafter, as each subsequent sample is received during a standard sampling cycle the most recent sample transmitted in accordance with the provisions of § 70.220 will be combined with the 10 samples contained in the current basic sample, the oldest sample discarded, and a determination of compliance or noncompliance made on the basis of the data recorded from the current basic sample.

(b) If the data recorded pursuant to § 70.261 for a current basic sample with respect to a working section of a coal mine establish an average concentration of respirable dust in excess of the average concentration stated in paragraph (b) of § 70.211, as applicable, the Secretary shall issue a notice to the operator that he has exceeded the applicable limit and is in violation of paragraph (a) or paragraph (c) of § 70.100 of this Part 70, as

the case may be. Paragraph (a) of § 70.100 prescribes a limit of 3.0 milligrams of respirable dust per cubic meter of air. Paragraph (c) of § 70.100 covers permits for noncompliance issued by the Interim Compliance Panel established by the Act.

**§ 70.222 Reduction in monthly standard sampling cycle.**

(a) Where the samples from a standard sampling cycle with respect to a working section of a coal mine have been included in the current basic sample and the data recorded for the current basic sample pursuant to § 70.261 establish a cumulative concentration at or below 30 milligrams of respirable dust per cubic meter of air, the Secretary may in writing, establish an alternating sampling cycle for such working section.

(b) Under an alternating standard sampling cycle established by the Secretary for a working section under the provisions of paragraph (a) of this section, the operator will not be required to take samples with respect to that working section during the following calendar month. If the current basic sample following completion of a standard sampling cycle during the third month shows that the cumulative concentration of respirable dust with respect to that working section has not exceeded the limit of 30 milligrams per cubic meter of air, the operator will not be required to take samples from the working section during the following month or during any alternating months after which a determination of compliance has been made in accordance with the provisions of paragraph (c) of § 70.221. For example:

July, basic sample in compliance: August, standard sampling cycle;
September, no sampling cycle: October, standard sampling cycle;
November, no sampling cycle: December, standard sampling cycle;
January, no sampling cycle: February, standard sampling cycle;
March, no sampling cycle: April, standard sampling cycle;
May, no sampling cycle: June, standard sampling cycle.

**§ 70.223 Alternating standard sampling cycle; return to monthly standard sampling cycle.**

When an alternating standard sampling cycle has been established for a working section under the provisions of § 70.222, the operator shall revert to the original sampling cycle provided in § 70.210, if, at any time, analysis of the samples contained in the current basic sample or an analysis based on a Bureau of Mines inspection with respect to such section show the cumulative dust concentration to be in excess of the limit of 30 milligrams per cubic meter of air.

PARTIAL SAMPLING CYCLE

**§ 70.230 Sampling cycles consisting of less than the required samples; general.**

(a) If the Secretary fails to recive the number of valid samples with respect to a working section required under the provisions of § 70.210 or § 70.220, or if any number of samples taken during a sampling cycle in accordance with the provisions of § 70.210 or § 70.220 have been rejected by the Secretary as invalid samples, the Secretary shall, in accordance with the provisions of § 70.261, analyze the samples transmitted to determine whether such working section is in compliance with the applicable respirable dust limit.

(b) If the Secretary receives less than the required number of valid samples with respect to a working section, and has determined in accordance with the provisions of paragraph (a) of this section that the cumulative concentration of respirable dust does not exceed the applicable limit set forth in paragraph (b) of § 70.211, the Secretary shall require the operator to initiate additional sampling. Upon receipt of advice that additional sampling is required, the operator shall commence such sampling on the first day on which there is a production shift following the day upon which he receives such advice from the Secretary pursuant to this paragraph, and shall continue to take such consecutive samples until he is advised in writing by the Secretary that the total number of valid samples required have been received. If such additional sampling requires that samples be taken during a subsequent calendar month, the additional samples taken during the subsequent calendar month shall not relieve the operator of his duty to sample during that month in accordance with the provisions of § 70.220.

(c) Where additional sampling is required under the provisions of paragraph (b) of this section and the Secretary receives more than the number of samples required under the provisions of § 70.210 or § 70.220 of this part, such additional samples shall be combined with the samples previously received and the most recent 10 samples shall constitute the basic sample under § 70.210 or the current basic sample under § 70.210.

(d) As additional samples are received by the Secretary in accordance with paragraph (b) of this section and combined with the valid samples already received, a daily determination of compliance or noncompliance shall be made with respect to that working section. If the data recorded pursuant to § 70.261 with respect to that working section, establish a cumulative concentration of respirable dust in excess of the cumulative concentration stated in paragraph (b) of § 70.211 with respect to the particular applicable limit, the Secretary shall issue a notice to the operator that he is in violation of paragraph (a) or paragraph (c) of § 70.100 of this Part 70.

METHODS OF SAMPLING WORKING SECTIONS

**§ 70.240 Monthly sampling procedures; general.**

The monthly sampling procedures set forth in this part with respect to working sections are designed to determine the average concentration of respirable dust to which the miners assigned to a working section of a coal mine are exposed, portal to portal. Accordingly, a provision that samples of respirable dust be taken "with respect to" a working section means that an approved sampling device should be attached to the miner or carried into the working section to which he is assigned when he enters or leaves the mine and that the device should remain operative during the entire shift—portal to portal.

**§ 70.241 Multisection mines.**

In a coal mine in which there are two or more working sections, the sampling cycle with respect to each working section shall be staggered with those taken in other working sections to provide continuous sampling of the mine atmosphere. For example, if there are three working sections, samples from each working section should be taken during different time periods. In order to provide continuous sampling, staggered sampling cycles may be overlapped.

**§ 70.242 Working sections; conventional mining.**

(a) Unless otherwise directed by an authorized representative of the Secretary, in a working section in which conventional mining methods are employed, the samples taken in the working section shall be confined to the operation of the cutting machine.

(b) In the working section, the approved sampling device may remain on the operator (if it is a coal mine dust personal sampler unit) or be placed on the machine which he operates. If the sampling device is placed on a machine, the device shall be installed adjacent to the operator within 36 inches inby his normal working position. In no case shall the device be installed behind the operator.

**§ 70.243 Working sections; continuous mining.**

Unless otherwise directed by an authorized representative of the Secretary:

(a) In a working section in which a continuous mining machine is employed, the approved sampling device may remain on the operator (if it is a coal mine dust personal sampler unit) or be placed on the machine which he operates; and

(b) If the sampling device is placed on a machine, the device shall be installed adjacent to the operator within 36 inches inby his normal working position. In no case shall the device be installed behind the operator.

**§ 70.244 Working sections; longwall mining.**

Unless otherwise directed by an authorized representative of the Secretary, with respect to a working section in which a longwall mining machine is used, the miner who workers nearest the return air side of the longwall face may wear the approved sampling device (if it is a coal mine dust personal sampler unit) or the device may be placed at a point in the return air current but in no case farther than 48 inches from the corner on the return side on the longwall face.

§ 70.245 Working sections; hand loading.

(a) With respect to a working section in which coal is loaded by hand, 10 percent of the hand loaders, and in no case less than one hand loader, shall wear an approved coal mine dust personal sampler unit.

(b) In the working section, the sampling units may remain on the hand loaders or, the devices may be placed at sites which represent the maximum concentrations of dust to which the hand loaders are exposed in the working section.

§ 70.246 Working sections; intake air.

During one production shift in every sampling cycle with respect to a working section, an approved sampling device shall be placed in the intake air course of that working section and a sample will be taken within 200 feet outby the working faces of such section.

SAMPLING OF INDIVIDUAL MINERS

§ 70.250 Individual sampling procedures; at least once every 180 days.

(a) Except as provided in paragraphs (b) and (c) of this section, one sample of respirable dust shall be taken from the mine atmosphere to which each individual miner is exposed at least once every 180 days, except those miners already sampled during such 180-day period in sampling cycles conducted under the provisions of §§ 70.210, 70.220, and 70.230.

(b) One sample of respirable dust shall be taken from the mine atmosphere to which each individual miner assigned to a working section is exposed at least once every 120 days, except those miners already sampled during such 120-day period in sampling cycles conducted under the provisions of §§ 70.210, 70.220, and 70.230 of this part.

(c) One sample of respirable dust shall be taken from the mine atmosphere to which each individual miner who has exercised his option to transfer in accordance with the provisions of § 203(b)(1) of the Act is exposed at least once every 90 days.

(d) The samples required under the provisions of this section shall be taken during any shift where the miner is employed in his usual occupation or in the occupation to which he was transferred.

TRANSMISSION AND ANALYSIS OF SAMPLES

§ 70.260 Respirable dust samples; transmission.

(a) At the conclusion of each production shift in a sampling cycle, the operator shall promptly collect and transmit all samples in a container provided by the manufacturer of the filter to:

Pittsburgh Field Health Group, Bureau of Mines, Department of the Interior, Pittsburgh, Pa. 15213.

(b) Each sample shall be accompanied by a completed 3 x 5 inch white data card identical to the card contained in Figure 1 of this Part 70, provided for this purpose by the cassette manufacturer. The card shall have an identification number identical to that on the cassette used to take the sample, and the name and Social Security number of the miner whose environment was being sampled. The data card shall be initialed by the miner whose environment was being sampled and the representative of the company responsible for the dust sampling procedure.

§ 70.261 Respirable dust samples; analysis by the Secretary; report to the operator.

Upon receipt by the Bureau of Mines of respirable dust samples taken with respect to a working section, each sample shall be analyzed and the following data shall be recorded:

(a) The mine identification number;

(b) The working section within the mine from which the samples were taken;

(c) The dust concentration, expressed in milligrams per cubic meter of air, for each sample;

(d) The cumulative total of respirable dust for all valid samples, exclusive of intake air, expressed in milligrams per cubic meter of air;

(e) The average dust concentration for all valid samples, exclusive of the sample of intake air, expressed in milligrams per cubic meter of air;

(f) The dust concentration, expressed in milligrams per cubic meter of air, for the intake air sample of each working section; and,

(g) The Social Security number of the individual miner whose environment was sampled.

§ 70.262 Report of data.

The Secretary shall provide the operator with a report of the data recorded pursuant to § 70.261 as soon as practicable.

MISCELLANEOUS

§ 70.270 Installation of sampling devices.

For purposes of sampling under the provisions of Subpart C of this part, the operator shall install all MRE sampling devices in a near level position and all coal mine dust personal sampler units in a near upright or vertical position.

§ 70.271 Spot inspections.

In order to obtain compliance with the provision of Part 70, the Bureau of Mines shall conduct frequent spot inspections of the active workings of coal mines.

§ 70.272 Report and certification of conditions in active mine workings.

Each operator of a coal mine shall, on or before June 30, 1970, and annually thereafter on the anniversary date of each initial report and certification, report and certify to the Secretary the conditions relative to dust control which exist in the active workings of all mines operated. Such reports shall be submitted on Bureau of Mines Form No. 6–1497. Report forms may be obtained from any Coal Mine Safety District Office of the Bureau of Mines. Reports shall be submitted to:

Office of Mineral Industry Health, Bureau of Mines, Department of the Interior, Washington, D.C. 20240.

## Subpart D—Respiratory Equipment

§ 70.300 Respiratory equipment; respirable dust.

(a) Respiratory equipment approved by the Secretary and by the Secretary of Health, Education, and Welfare shall be made available to all persons whenever exposed to concentrations of respirable dust in excess of the levels required to be maintained under this Part 70. Use of respirators shall not be substituted for environmental control measures in the active workings. Each operator shall maintain a supply of respiratory equipment adequate to deal with occurrences of concentrations of respirable dust in the mine atmosphere in excess of the levels required to be maintained under this Part 70.

§ 70.300–1 Approved respiratory equipment; respirable dust.

(a) Filter-type respirators approved on and after January 19, 1965, under Part 14 of this chapter (Bureau of Mines Schedule 21B) and supplied-air respirators, Type G, approved on and after April 19, 1965, under Part 12 of this chapter (Bureau of Mines Schedule 19B) for protection against pneumoconiosis-producing dust, toxic dust, pneumoconiosis-producing mist, toxic mist, and toxic fumes are approved respiratory equipment for the purposes of § 70.300.

(b) Respirators approved during the period April 12, 1953, through January 18, 1965, under Part 14 of this chapter (Bureau of Mines Schedule 21A), and in use on or before June 30, 1970, for protection against pneumoconiosis-producing dust, toxic dust, pneumoconiosis-producing mist, toxic mist, and toxic fumes are approved respirators for the purposes of § 70.300 until December 31, 1970. Such respirators shall not be provided for protection under the provisions of § 70.300 on or after January 1, 1971.

§ 70.305 Respiratory equipment; gas, dusts, fumes, or mists.

Respiratory equipment approved by the Secretary and the Secretary of Health, Education, and Welfare shall be provided persons exposed for short periods to inhalation hazards from gas, dusts, fumes, or mist. When the exposure is for prolonged periods, other measures to protect such persons or to reduce the hazard shall be taken.

§ 70.305–1 Approved respiratory equipment; gas, dusts, fumes, or mists.

Respiratory equipment which has been approved by the Bureau of Mines under the parts of this chapter, on and after the dates listed in this section, are approved respiratory equipment for the purposes of § 70.305 but only with respect to the specific hazards referred to in the approved labels:

Part 13—Gas Masks (Bureau of Mines Schedule 14F) April 23, 1955;

Part 14—Filter-type, Dust, Fume, and Mist Respirators (Bureau of Mines Schedule 21B) January 10, 1965;

Part 14a—Non-Emergency Gas Respirators (Chemical Cartridge Respirators Including Paint Spray Respirators) (Bureau of Mines Schedule 23B) August 4, 1959.

### Subpart E—Dust From Drilling Rock

**§ 70.400 Dust from drilling rock; control.**

The dust resulting from drilling in rock shall be controlled by use of permissible dust collectors, or by water or water with a wetting agent, or by ventilation, or by any other method or device approved by the Secretary which is at least as effective in controlling such dust.

**§ 70.400–1 Dust from drilling rock; approved devices.**

Dust collectors approved by the Bureau of Mines under Part 33 of this chapter (Bureau of Mines Schedule 25B) are permissible dust collectors for the purposes of § 70.400.

**§ 70.400–2 Dust from drilling rock; water.**

Water used to control dust from drilling rock shall be applied through a hollow drill steel or stem or by the flooding of vertical drill holes in the floor.

**§ 70.400–3 Dust from drilling rock; ventilation.**

In order to control adequately dust from drilling rock, the air current shall be so directed that the dust is readily dispersed and carried away from the drill operator or any other worker in the area.

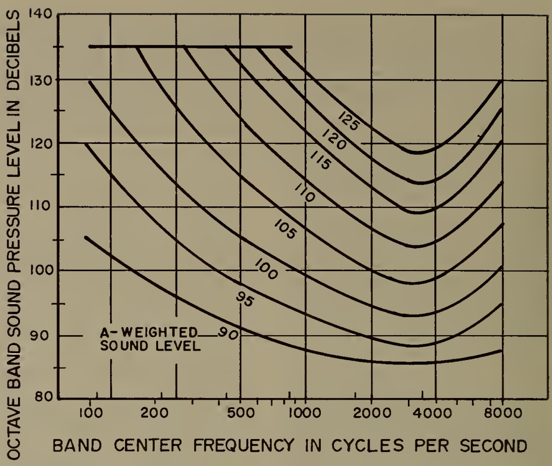
### Subpart F—Noise Standard

**§ 70.500 Noise standard.**

(a) On and after June 30, 1970, the standards on noise prescribed under the Walsh-Healy Public Contracts Act, as amended, in effect on October 21, 1969, shall be applicable to each coal mine and each operator of such mine shall comply with them. The standard referred to is as follows:

#### Occupational noise exposure

"(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table I of this section when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:




"Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table I.

"(b) When employees are subjected to sound exceeding those listed in Table I of this section, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of the table, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

"(c) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered intermittent. In such cases, where the duration of the maxima are less than 1 second, they shall be treated as of 1-second duration.

"(d) In all cases where the sound levels exceed the values shown herein, a continuing, effective hearing conservation program shall be administered.

TABLE I

PERMISSIBLE NOISE EXPOSURES [1]

| *Duration per day, hours* | *Sound level dBA* |
|---|---|
| 8 | 90 |
| 6 | 92 |
| 4 | 95 |
| 3 | 97 |
| 2 | 100 |
| 1½ | 102 |
| 1 | 105 |
| ½ | 110 |
| ¼ or less | 115 |

[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C1/T1 + C2/T2 \ldots Cn/Tn$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

"Exposure to impulsive or impact noise should not exceed 140 dBA peak sound pressure level."

(b) In meeting the standard set forth in paragraph (a) of this section, the

operator shall not require the use of any protective device or system, including personal devices, which the Secretary or his authorized representative finds to be hazardous or cause a hazard to the miners in such mine.

FIGURE 1

MINE DATA CARD

Sample No. ---------------- Initial Wt. ----------------------
Mine ID No. ---------------- Final Wt. ----------------------
Section ID No. -------------- Sampling time (Min.) -----------
Miner's SSA No. ------------ Date ---------------------------
Occupation ---------------------------------- Tons this shift -----------
Type of Sample:
High risk ------------ Nonhigh risk ------------ Intake air ------------
Face ventilation:
Exhaust ------------ Blowing ------------ Aux. ------------ Brattice ------------
Type of Mining:
Development ------------ Retreat ------------
Method of Mining:
Continuous ------------ Conventional ------------ Longwall ------------
Other ------------
------ Check if section will close before next sampling cycle.

Signature:
(Miner Sampled) -----------------------------------
(Mine Official) -----------------------------------

[F.R. Doc. 70-4100; Filed, Apr. 2, 1970; 8:51 a.m.]

APPENDIX E.--MINE INFORMATION REPORT

Form 6-1497
(March 1970)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Budget Bureau No. 42-R 1594
Approval Expires June 1971

## CONDITIONS IN THE ACTIVE WORKINGS OF THE COAL MINE

Section 202 (a) of the Federal Coal Mine Health and Safety Act provides that each operator shall report and certify to the Secretary of the Interior at such intervals as the Secretary may require as to the conditions in the active workings of the coal mine, including, but not limited to, the average number of working hours worked during each shift, the quantity and velocity of air regularly reaching the working faces, the method of mining, the amount and pressure of the water, if any, reaching the working faces, and the number, location, and type of sprays, if any used.
The operator is required to supply one completed form to the Coal Mine Safety District Manager for the district in which the mine is located on or before July 1, 1970, and once each year thereafter. Forms are available upon request at each Coal Mine Safety District Office or Subdistrict Office of the U.S. Bureau of Mines.

1. Identification:
   - (a) Coal Company Name: ..........
   - (b) Address: Street .......... City ..........
     State .......... Zip ..........
   - (c) Phone: Area Code .......... Number ..........
   - (d) District or Division name: ..........
   - (e) Mine Name ..........
   - (f) Address: City .......... County ..........
     State .......... Zip ..........
   - (g) Phone: Area Code .......... Number ..........

2. Identification Number: Mine .......... Section ..........

3. Description of Mine:
   - (a) Name of coalbed ..........
   - (b) Seam thickness .......... Inches
   - (c) Average depth of overburden .......... Feet

| | | |
|---|---|---|
| (d) Proximate Analysis | Moisture .......... | Percent .......... |
| | Volatile matter .......... | Percent .......... |
| | Fixed carbon .......... | Percent .......... |
| | Ash .......... | Percent .......... |
| | Sulfur .......... | Percent .......... |
| | Calorific Value, BTU .......... | |

4. Production:
   - (a) Number of production shifts per day. ☐
   - (b) Average number of working hours per production shift ☐
   - (c) Number of underground miners ☐
   - (d) Average tons per shift ☐

5. Ventilation:

| | Blowing | Exhausting | Aux. Fans | Natural |
|---|---|---|---|---|
| (a) Type used (Check appropriate box/boxes | | | | |

   - (b) Volume of intake air at last open crosscut ..........
   - (c) Volume of return ..........
   - (d) Velocity in entry ..........
   - (e) Is Diffuser used? (Check appropriate box) Yes ☐ No ☐

6. Mining Method:

| | | | | |
|---|---|---|---|---|
| Type (Check Appropriate box/boxes) | ☐ Developing | ☐ Retreating | ☐ Longwall | ☐ Handloading |

7. Mining Equipment: (Check appropriate boxes)
   - (a) Continuous Miner ☐
     - (1) Type and model ..........
     - (2) Bits Type ..........
       Number ..........
     - (3) Penetration .......... Inches per minute
   - (b) Longwall Machine ☐
     - (1) Type and model ..........
     - (2) Depth of cut .......... Inches
     - (3) Bits Type ..........
       Number ..........
     - (4) Speed of travel .......... Feet per minute ..........
   - (c) Auger miner ☐
     - (1) Type and model ..........
     - (2) Diameter of twist ..........
     - (3) Bits Type ..........
       Number ..........
     - (4) Penetration .......... Inches per minute

(d) Mining Machine (Cutting Machine) ☐

(1) Type and model ....................

(2) Length of cutter bar .................... Feet

(3) Thickness of Curf .................... Inches

(4) Average time to cut and/or shear each place .................... Minutes

(5) Bits Type ....................

Number ....................

(e) Coal Drill ☐

(1) Type and model ....................

(2) Hole diameter .................... inches. Depth drilled .................... Inches

(3) Type of dust control, if any ....................

(4) Average number of holes per face ....................

(f) Loading machine ☐

(1) Type and model ....................

(2) Type of operation: (Check one)

Loading behind continuous miner ☐ Loading blasted coal ☐

(3) Number of water sprays ....................

(4) Number of water sprays in use ....................

(5) Approximate rate of water flow .................... Gallons per minutes

(6) Approximate water pressure .................... psig

(g) Conveyor ☐

(1) Type and model ....................

(2) Width of belt or conveyor pan .................... Inches

(3) Speed .................... Feet per minute

(h) Roof bolter ☐

(1) Type and model ....................

(2) Hole diameter .................... inches. Depth drilled .................... inches

(3) Type of bits used ....................

(4) Type of dust control ....................

(i) Water sprays, *wherever used* ☐

(1) Number of sprays ....................

(2) Number in operation ....................

(3) Type and model ....................

Check one

(4) Hollow cone ☐ Filled cone ☐

(5) Water pressure .................... psig

(6) Water flow (where operating) .................... Gallons per minute

(j) Auxiliary fans ☐

| | Fan #1 | Fan #2 | Fan #3 |
|---|---|---|---|
| (1) Type | | | |
| (2) Model | | | |
| (3) Size | | | |
| (4) Horsepower | | | |
| (5) Volume of air moved (CFM) | | | |
| (6) Length of tubing (feet) | | | |
| (7) Size of tubing (feet) | | | |
| (8) Check if blowing | | | |
| (9) Check if exhausting | | | |
| (10) Method of installation | | | |
| (11) Distance from end of tubing to face—(feet) | | | |
| (12) Check if this distance is maintained | | | |

(k) Shuttle cars or trailers ☐

(1) Type ....................

(2) Approximate load per car ....................

(3) Roadway (Check appropriate box/boxes)

Wet ☐ Dry ☐ Dust control used ☐

....................
Signature

....................
Title

IC bureau of mines information circular 8485



# A METHOD FOR EXTINGUISHING AND REMOVING BURNING COAL REFUSE BANKS

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
1970

# A METHOD FOR EXTINGUISHING AND REMOVING BURNING COAL REFUSE BANKS

By Frank C. Andreuzzi

* * * * * * * * * * * information circular 8485

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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# A METHOD FOR EXTINGUISHING AND REMOVING BURNING COAL REFUSE BANKS

by

Frank C. Andreuzzi [1]

## ABSTRACT

The Division of Environmental Activities, U.S. Bureau of Mines, conducted a solid waste demonstration project on a burning coal refuse bank. The primary objective of this project was to develop and evaluate an efficient method of extinguishing burning coal refuse and moving it. A series of tests were performed using water monitors and related apparatus to quench the burning material and, at the same time, using earth-moving equipment to transport, spread, and compact the extinguished material.

The method found to be most effective consisted of water-quenching the surface material to a workable depth, ripping, and removing the quenched material with a bulldozer and tractor-scraper. The total cost was estimated to be $0.44 per cubic yard.

## INTRODUCTION

Burning coal refuse banks are a significant local source of air pollution. The smoke and fumes emitted from these banks are obnoxious and a hazard to the health of the general public. In addition, the banks may not only occupy valuable land that could otherwise be used for industrial, residential, and other development purposes, but also, the appearance of these banks detracts from the aesthetics of the environment.

In 1963, a Bureau of Mines survey revealed that 495 coal refuse banks were burning in 15 of the 26 coal-producing States (5).[2] It is difficult to determine the direct cause of many of the bank fires, some of which have been burning for a number of years. Some of these fires are attributed to (1) man's reckless burning of trash on or near the bank; (2) an abandoned mine fire under the bank that has been broken through to the surface; (3) possibly spontaneous combustion; and (4) brush, forest, and camp fires (2-3).

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[1] General engineer, Mineral Resource Evaluation, Environmental Affairs Field Office, Bureau of Mines, Wilkes-Barre, Pa.

[2] Underlined numbers in parentheses refer to items in the bibliography at the end of this report.

The major air pollutants emitted from burning coal refuse banks include sulfur dioxide ($SO_2$); hydrogen sulfide ($H_2S$); carbon monoxide (CO), carbon dioxide ($CO_2$), and suspended particulate matter. During times when an area experiences a temperature inversion, the air pollutant concentration can reach serious levels. High concentration of these contaminants may have toxic effects on human, animal, and plant life. Property damage is also attributable to these gases. Hydrogen sulfide attacks lead-base paints, and sulfur dioxide which converts to sulfur trioxide when combined with moisture becomes corrosive to many metals. At times this corrosive mist reaches a high level of concentration and impairs visibility.

Many attempts have been made by coal companies, State and Federal Government agencies to control burning coal refuse banks. Several of the methods which have been employed or have been tested include the following:

Isolation.--This method involves the excavation of a trench to natural surface, thereby separating the burning portion from the nonburning refuse. Following isolation, the burning portion of the bank is blanketed with incombustible material.

Blanketing.--A covering mantle of fine incombustible clay material several feet in depth is applied on the entire bank and serves to smother the fire by excluding air. This method requires continued maintenance to assure the seals effectiveness.

Grouting.--A slurry of water and finely divided incombustible material, such as pulverized limestone or sand, is forced into the burning bank. By filling the voids, air is excluded from the refuse with the slurry providing some cooling action.

Explosives.--Explosive charges placed deep into a bank through horizontally drilled boreholes are used to create fissures in the fused material. Water is then applied through the newly formed crevices and the quenched material is loaded out.

Spraying.--Continuous application of a fine water spray over the entire refuse bank is utilized in this method. Water must be applied until all evidence of hot spots are eliminated. The effectiveness of this method is principally dependent upon the cooling action of the water, since no material is removed.

Loading-Out.--The loading-out method is generally applied to small fires and consists of hydraulically cooling and excavating the burning material. The method found most effective in this demonstration project may be considered a refinement of the load-out method.

The demonstration project discussed in this report was undertaken by the Bureau of Mines under the authority of Public Law 89-272, the Solid Waste Disposal Act, with the purpose of developing a feasible method of extinguishing and redepositing quenched refuse material.


FIGURE 1. - General Area Location Map.

The basic technique consisted of using high-pressure water nozzles and spray piping to reduce the temperature of the refuse material. Following the quenching operation various units of earth-moving equipment were used to transport, spread and compact the material.

By competitive bidding and contract, a private company furnished all necessary labor, materials, and earth-moving equipment, in compliance with project specifications engineered by the Bureau of Mines. All testing and experimentation were supervised by Bureau personnel.

## DESCRIPTION OF PROJECT SITE

The demonstration project site locally referred to as the Baker Bank is located in the city of Scranton, Pa., (population 111,443, 1960 Census of Population). The coal refuse bank is situated on the west-central border of the city (fig. 1).

The actual cause of the fire is unknown; however, burning and smoldering material was first detected at the western foot of the bank in 1960. In an earlier effort to isolate and control this fire, the bank was divided by a trench into two sections (figs. 2 and 3). This effort proved unsuccessful and the fire eventually spread throughout the entire bank. The Baker Bank is estimated to contain 3.5 million cubic yards of refuse covering approximately 48 acres.


FIGURE 2. - Configuration of Baker Bank Prior to the Demonstration Project.

FIGURE 3. - Aerial View at the Start of the Demonstration.

The bank was built by depositing refuse that was separated from the marketable coal in a preparation plant. The refuse material ranged in size from six inches to three-sixty-fourth inch. The refuse in the bank consisted of coal, rock, slate, shale, "bone" (a term applied to material containing thin strata or layers of slate sandwiched between coal), and pyritic compounds. As a result of years of continuous burning, the bank has been transformed into what appears to be a mountain of ash, predominantly red in color and commonly called "red dog." The composition is now loose ash, burning and unburned carbonaceous material, and a conglomeration of material which has become fused into slaglike masses with nearly the hardness of concrete.

The Bureau's demonstration project was confined to the east section of the bank, an area of approximately 12 acres (fig. 2). This section of the bank averaged 137 feet in height and contained an estimated 1.1 million cubic yards of material.

Water for quenching the burning refuse material was pumped from a vertical shaft which interconnects several levels of an inundated abandoned coal mine. A vertical, deep-well pump, rated at 4,000 gpm was used on the project. Approximately 900 feet of pipeline was required from the shaft to the project site.

A strip-mine pit, approximately 64 feet in depth, adjacent to the demonstration site was backfilled with the quenched material, compacted and graded to correspond with the surrounding terrain (fig. 2).

## PROCEDURE AND RESULTS

### Hydraulicking With Bulldozer Haulage

The basic techniques used in this phase of the demonstration consisted essentially of quenching and sluicing the hot material with the available mine water and pushing it by bulldozer into the adjacent strip pit (fig. 4). Operations were conducted on a one-shift basis, 5 days per week. The operating personnel included six men: a pump operator, bulldozer operator, and four laborers.

The equipment used for this series of tests consisted of 6-inch water monitors (fig. 5), all monitors were operated at the rated 100 psig, used singly or in batteries of two and three units. A variety of commercial nozzles were used to determine their effectiveness (fig. 6).

A bulldozer pushed the cooled refuse from the bank into the adjacent strip pit.

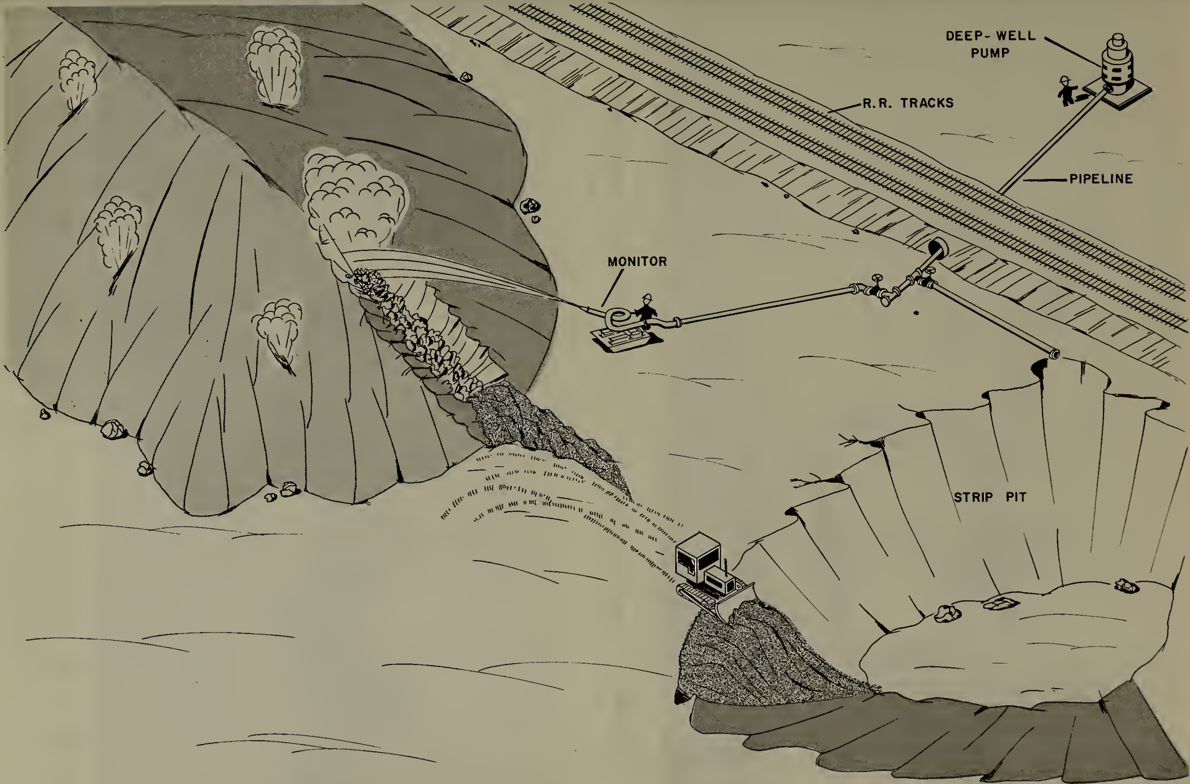


FIGURE 4. - Drawing Illustrating Hydraulicking With Bulldozer Haulage.

FIGURE 5. - Six-Inch Water Monitor and 4,000-gpm Straight Stream Nozzle.

FIGURE 6. - Commercial Nozzles, From Left, a 1,000-, a 2,000-, and a 4,000-gpm Straight Stream Nozzle, and a 2,000-gpm Fog Nozzle.

The quenching and haulage rates in the following tests, conducted to determine the optimum quenching and haulage rate, were the estimated quantities derived from observation and comparison:

1. Two monitors, each equipped with a 2,000-gpm fog nozzle, were placed at the foot of the bank (fig. 7), approximately 20 feet apart. Water from each unit was directed over separate areas of the bank. The nozzles were operated at several settings, ranging from a straight stream discharge to the maximum fog pattern. The straight stream setting was used for quenching and sluicing while the fog pattern was intended to control dust and fumes; however, the straight stream jets proved to be effective in controlling air pollutants. The quenching and haulage rate for this particular test was 40 cubic yards per hour.

2. The same general procedure, as described in paragraph 1, was used in the second test except one of the 2,000-gpm fog nozzles was replaced by a 2,000-gpm straight stream nozzle. Again, the monitors were directed on separate areas of the bank, independent of each other.

The straight stream nozzle had a greater impact than was observed with the fog nozzle. This resulted in an increase of 25 percent in the quenching and haulage rate, amounting to 50 cubic yards per hour.

3. A third monitor was added and located adjacent to the two units used in the previous tests. Two monitors were equipped with 1,000-gpm straight stream nozzles instead of the 2,000-gpm nozzles, and the third unit used a 2,000-gpm fog nozzle. The lower capacity nozzles were not effective in sluicing the refuse material in individual areas; therefore, both monitors were directed on one section of the bank.

The fog nozzle was operated exclusively in the straight stream setting. The quenching and haulage rate did not show any increase while using this arrangement of nozzles even though an extra monitor was installed. This test achieved only 50 cubic yards per hour.

4. Two monitors, both equipped with 2,000-gpm straight stream nozzles, were tested. In the initial period of the test each monitor was directed on a separate area of the bank and operated independent of the other. A greater yield per hour was achieved, however, when both monitors were directed on the same section, thereby concentrating the total 4,000 gpm on one area. The volume of material quenched and hauled increased by 40 percent, equivalent to 70 cubic yards per hour.

5. A single monitor was tested using a 4,000-gpm straight stream nozzle (fig. 8). This arrangement provided the maximum efficiency in stream control, water concentration, and sluicing action. One-hundred-and-twenty cubic yards per hour, the highest rate compared to all preceding tests, was achieved using this high-volume monitor.

6. In all of the preceding tests the monitor or monitors were placed below the elevation at which the water stream made contact with the bank. In this test one monitor using a 4,000-gpm nozzle was positioned on top of the bank. This required quenching and cutting a ramp over hot portions of the bank to permit moving the monitor and supporting the pipeline.

FIGURE 7. - Typical Multimonitor Operation.

FIGURE 8. - Single-Monitor Operation Using a 4,000-gpm Nozzle.

It was assumed that the monitor located on the top of the bank with the water stream pushing material downward would increase the hourly rate; however, no significant increase in the hourly rate was observed. The quenching action of the hydraulicking operation was effective in reducing the temperature of the hot and burning material to below 150° F. The temperature of the refuse was further lowered to ambient air temperatures as it was pushed by the bulldozer for disposal in the strip pit. The temperature of quenched material both at the bank and disposal area was monitored daily.

The results of the various tests indicate that the single, higher capacity monitor was more effective in quenching and moving the burning material than several low-capacity monitors operating together (table 1). The amount of material removed by the water was limited to the loose rock dislodged by the hydraulic action of the monitors. The sluicing effect of water on the loose material proved to be of little advantage because of the following factors:

1. The relatively flat shape of the loose material.

2. The infiltration of water into the porous bank.

3. Increased frictional loss on the irregular surface of the bank (fig. 9).

TABLE 1. - *Summary of hydraulicking with bulldozer haulage*

| Test[1] | Monitors | Nozzles | | | Material quenched and moved, cubic yards per hour |
|---|---|---|---|---|---|
| | | Number and type | | Capacity, gallons per minute | |
| | | Fog | Straight stream | | |
| 1 | 2 | 2 | - | 2,000 | 40 |
| 2 | 2 | 1 | 1 | 2,000 | 50 |
| 3 | 2 | - | 2 | 1,000 | 50 |
| | 1 | 1 | - | 2,000 | |
| 4 | 2 | - | 2 | 2,000 | 70 |
| 5 | 1 | - | 1 | 4,000 | 120 |
| [2]6 | 1 | - | 1 | 4,000 | 120 |

[1]Water stream directed upward, except test 6.
[2]Water stream directed downward.

It was necessary to relocate the monitor frequently to provide sufficient hydraulic force to advance the material.

One of the difficulties encountered during the demonstration was to dislodge and fracture large embedded slaglike masses found throughout the refuse bank. Hydraulic undercutting was tried to dislodge the slag "boulders." For example, one slag boulder required 12 to 16 hours of continuous hydraulicking before it was dislodged (fig. 10). The bulldozer was then required to push it off the bank (fig. 11).

A mechanical method of crushing and/or dislodging the slag formations was also tried. A steel-wrecking ball was swung repeatedly from a crane against

FIGURE 9. - Surface of Bank After Hydraulicking.

FIGURE 10. - Fused Slag Formation.

FIGURE 11. - Removing Fused Slag.

the face and sides of the hardened slag surface as well as dropped a number of times on the same general area. The steel ball had only a minimal affect on the hardened slag.

The atmosphere in the working area of the burning bank occasionally became laden with noxious fumes and during these periods the operating personnel were required to use a breathing apparatus, consisting of a rubber-mask face piece, pressure regulator, airflow demand regulator, hose, and a standard 244-cubic-foot compressed air cylinder.

The prevailing wind direction often was a factor to be considered when locating the monitors. Generally, the monitors were directed to spray downwind to protect the operator from the backwash, steam, and fumes.

## Estimated Costs

The following assumptions and/or criteria were made to estimate the costs in both methods:

1. Capital cost of the pump installation was based on prices of new equipment. The deep-well pump is one type used in some mining operations. The available water supply would determine whether or not pumping equipment is necessary.

2. The capital cost of the earth-moving equipment was based on dealers list prices. These machines are standard equipment for the excavating, paving, and general construction contractors.

3. Direct labor costs were based on the June 20, 1969, to October 16, 1969, U.S. Department of Labor Wage Determination Decisions.

4. Straight-line depreciation on equipment was as follows: pump, 5 years; earth-moving equipment, 10 years.

5. If this work were to be contracted out, sufficient yardage would have to be involved in the project.

6. Work schedule should consist of 240 days per year, 1 shift per day, 8 hours per day where applicable.

7. No regular mechanic-labor work should be included in maintenance and supplies.

The costs which are determined in this report apply only to the given conditions, but by following the same procedure and using appropriate prices an estimate may be made on similar projects.

Table 2 shows the equipment capital cost summary for this method. The Manning table is shown in table 3. Equipment used for this series of tests follows:

Pump - vertical turbine type, deep-well:[1]

| | | |
|---|---|---|
| Capacity | 4,000 | gpm |
| Hydrostatic head | 580 | feet |
| Motor | 800 | hp |
| Speed | 1,200 | rpm |
| Voltage | 2,300/4,160 | |
| Phase | | 3 |
| Cycle | | 60 |

Monitors (3 units)

Nozzles (various types and sizes)

Bulldozer:

| | |
|---|---|
| Flywheel rating (hp) | 270 |

[1]Including necessary transformers, switching gear, and accessories.

TABLE 2. - *Equipment capital cost summary, hydraulicking with bulldozer haulage*

| Item | Cost: Material | Cost: Labor | Total cost |
|---|---|---|---|
| Deep-well pump (1)........................... | $30,000 | $25,000 | $55,000 |
| Transformer, etc., for pump.................. | 10,000 | 5,000 | 15,000 |
| Pumphouse (1)................................ | 2,500 | 500 | 3,000 |
| Pipelines.................................... | 2,600 | 300 | 2,900 |
| Monitors (3)................................. | 6,200 | 200 | 6,400 |
| Bulldozer (1)................................ | 76,700 | - | 76,700 |
| Miscellaneous................................ | 12,500 | 1,600 | 14,100 |
| Total direct............................. | - | - | 173,100 |
| Field indirect (50 percent of labor)........ | - | - | 16,300 |
| Total construction....................... | - | - | 189,400 |
| Engineering (2 percent total construction).. | - | - | 3,800 |
| Overhead and administration (2 percent of total construction)........................ | - | - | 3,800 |
| | | | 197,000 |
| Contingency (10 percent).................... | - | - | 19,700 |
| | | | 216,700 |
| Fee (2 percent)............................. | - | - | 4,300 |
| Total cost (insurance base)............ | - | - | 221,000 |

TABLE 3. - *Manning table, hydraulicking with bulldozer haulage*

| Labor | Wages: Per day | Wages: 240 days per yr |
|---|---|---|
| Pump operators (1).................... | $33.04 | $7,929 |
| Bulldozer operators (1)............... | 42.00 | 10,080 |
| Laborers (4).......................... | 31.60 | 30,336 |
| Total wages...................... | - | 48,345 |
| Supervision (15 percent of total wages).................. | - | 7,250 |

The highest haulage production rate obtained in this method, 120 cubic yards per hour (table 4), was used in calculating the annual production, 120 cubic yards per hour x 8 hours per day x 240 days per year = 230,400 cubic yards per year. The total cost was $0.66 per cubic yard. Table 5 shows the estimated working capital for the period indicated.

TABLE 4. - *Estimated annual operating costs, hydraulicking with bulldozer haulage*

| Item | Annual cost | Cost per cubic yard[1] |
|---|---|---|
| Direct cost: | | |
| Production labor.................. | $48,345 | $0.21 |
| Supervision (15 percent of labor).. | 7,250 | .03 |
| | 55,595 | .24 |
| Operating supplies: | | |
| Maintenance and repairs........... | 2,300 | .01 |
| Fuel and lubrication.............. | 2,800 | .01 |
| | 5,100 | .02 |
| Power............................. | 15,200 | .07 |
| Payroll overhead (35 percent of payroll)......................... | 19,450 | .08 |
| Total direct cost.............. | 95,345 | .41 |
| Indirect cost: | | |
| 15 percent of maintenance, labor, and supplies.................... | 9,100 | .04 |
| Fixed cost: | | |
| Taxes and insurance (2 percent of equipment capital cost)......... | 4,420 | .02 |
| Depreciation...................... | 13,700 | .06 |
| | 18,120 | .08 |
| Profit: | | |
| Assumed 12 percent of equipment, capital cost, and estimated working capital................. | 30,720 | .13 |
| Total annual operating cost..... | 153,285 | .66 |

[1]Based on 230,400 cubic yards per year.

TABLE 5. - *Estimated working capital, hydraulicking with bulldozer haulage*

| | |
|---|---|
| Direct labor................................ | $12,000 |
| Payroll overhead............................ | 4,900 |
| Operating supplies.......................... | 1,300 |
| Indirect cost............................... | 3,000 |
| Fixed cost (5 percent of insurance base)........ | 11,000 |
| Spare parts................................. | 1,000 |
| Miscellaneous............................... | 1,800 |
| Total.................................. | 35,000 |

## Quenching With Tractor-Scraper Haulage

This phase of the demonstration consisted of quenching the hot coal refuse with the water monitors and a sprinkler system. A bulldozer was used primarily for ripping the quenched material while a tractor-scraper transported, spread, and compacted the extinguished material (fig. 12).

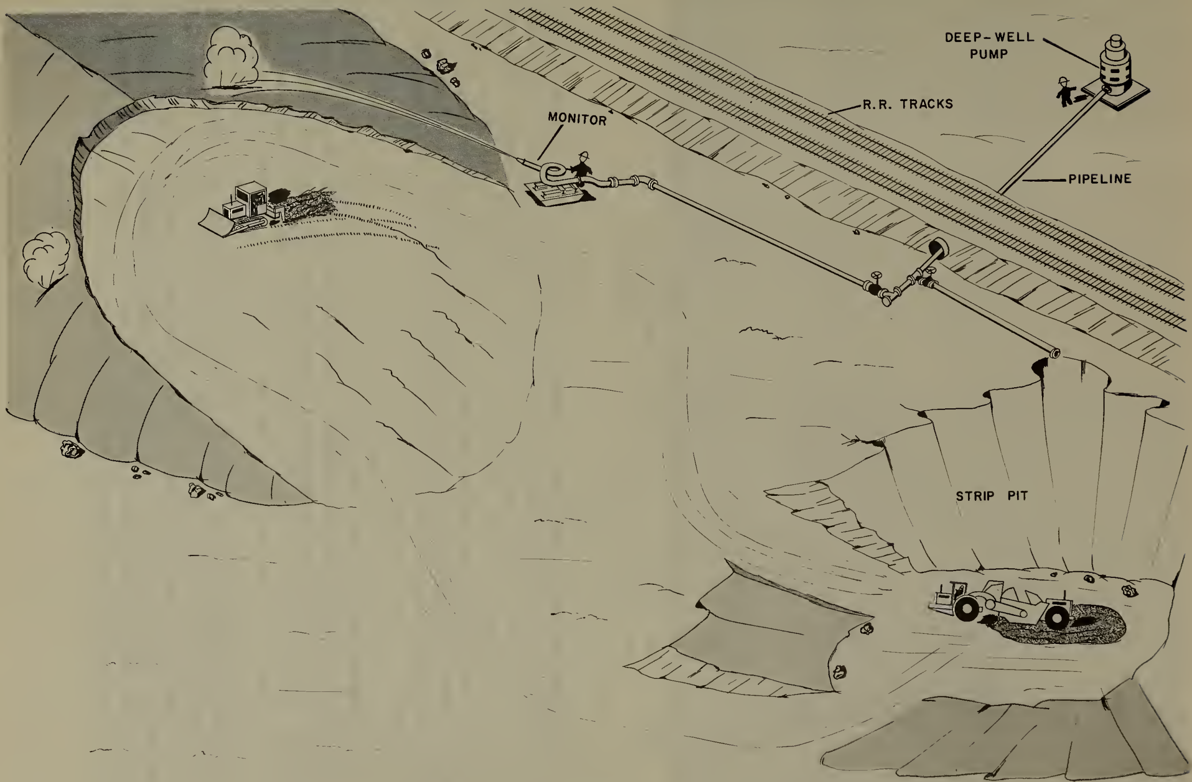


FIGURE 12. - Drawing Illustrating Quenching With Tractor-Scraper Haulage.

FIGURE 13. - Fabricated Flat Type Nozzle.

Prior to the testing work it was necessary to construct access roads and ramps from the top of the bank to the disposal area to facilitate haulage.

During construction of the ramps hot spots on the surface were encountered. These areas had to be cooled before the construction of the ramp could begin. The bulldozer was also used to prepare the ramps in the strip pit since no quenching was required.

The testing was on a three-shift basis, 5 days per week. On the first shift a quenching and hauling operation was conducted. The operating personnel included five men: a pump operator; bulldozer operator; tractor-scraper operator; and two laborers. On the second and third shifts one laborer was required on each shift to quench an area in preparation for the next day's haulage. It was both advantageous and economical to quench on an around-the-clock basis because quenching could be concentrated on the extremely hot and gaseous areas.

The equipment used during this phase consisted of a 6-inch water monitor and a 4,000-gpm straight stream nozzle. In addition, a fabricated flat-type nozzle was used (fig. 13). It was made from a piece of 4-inch diameter, schedule 40, 10-inch long steel pipe. The discharge end was flattened to form an elongated shape and the opposite end was threaded with standard pipe thread.

Fabricated sprinkler pipes were laid and used during the overnight quenching operation (fig. 14). A series of holes were drilled in 6-inch id by 20-foot-long aluminum irrigation pipes. The holes were five-eight inch in diameter, spaced on 12-inch centers on opposite sides of the pipe. The lightweight pipe was easily connected by simple hook-type couplers, and a complete setup could be made in less than 1 man-hour.

FIGURE 14. - Fabricated Sprinkler Pipes.

The original bulldozer was replaced by a larger unit rated at 389 flywheel hp, equipped with rear-end rippers. This larger machine was used to cut through the fused material and to operate in tandem with the tractor-scraper during its loading operation.

The surface temperature of the bank before quenching varied widely on different areas. The surface temperatures ranged from ambient air temperatures on areas of ash or red dog through 200° F on steaming areas and reached 700° F in gaseous areas. Some areas exposed glowing material and flames through cracks and fissures. The temperature of the quenched material averaged about 150° F which was safe for the earth-moving equipment to handle. Occasionally minor explosions occurred deep below the surface of the bank. This was caused by the formation of water gas when the steam contacted the incandescent carbon.

The operating procedure was as follows: The first-shift operation consisted of using the water monitor for quenching an area approximately 100 feet square. Because of its greater range, a distance of approximately 300 feet, the straight stream nozzle allowed quenching at a safe distance from the hot spots. For close-range quenching, the fabricated flat-type nozzle was effective in supplying a deluge over a wider area. Quenching continued until the refuse had been cooled to a depth of several feet.

FIGURE 15. - Empty Tractor-Scraper Ascending Bank.

FIGURE 16. - Tractor-Scraper Loading Itself With Quenched Material While Descending Bank.

FIGURE 17. - Tractor-Scraper Unloading Itself by Spreading and Compacting Quenched Material.

FIGURE 18. - Bulldozer Using Rear End Rippers to Rout Solid Fused Material.

Operating on a continuous cycle, the tractor-scraper would scrape a load of cooled material (figs. 15 and 16), transport and spread the material in layers averaging 14 inches in thickness (fig. 17) in the adjacent disposal site. The temperature of the quenched material which was deposited in the strip pit decreased to ambient air temperature in approximately 10 minutes.

The bulldozer, using its rippers, was effective in furrowing the slag formations (fig. 18). Further crushing was accomplished by the leading edge (blade) of the tractor-scraper as it cut its way through while loading. The combined action of the rippers and scraper blade crushed the fused material and virtually eliminated the slag-boulder problem.

## Estimated Costs

The duration of this test was 90 days. Data accumulated are as follows:

| | |
|---|---|
| Total tractor-scraper cycles...................... | 5,839 |
| Total tractor-scraper operating hours............. | 623 |
| Average trips per hour............................ | 9.4 |
| Estimated pay load per cycle (cubic yards)........ | 32 |
| Haulage production (cubic yards per hour)......... | 300 |
| Total volume of material moved (cubic yards)...... | [1]187,000 |

[1]Rounded.

The hourly production rate of 300 cubic yards was used in calculating the annual production: 300 cubic yards per hour x 8 hours per day x 240 days per year = 576,000 cubic yards per year.

Equipment capital cost summary and the Manning data are listed in tables 6 and 7, respectively. Equipment used for this method follows:

Pump and accessories were the same as those used in the hydraulicking with bulldozer haulage method:

Bulldozer:

| | |
|---|---|
| Flywheel rating (hp)............................ | 389 |

Tractor-scraper:

| | |
|---|---|
| Flywheel rating (hp)............................ | 900 |

The unit operating cost to quench and move material by this method was estimated to be $0.44 per cubic yard (table 8). Table 9 shows the estimated working capital for the period indicated.

TABLE 6. - *Equipment capital cost summary, quenching with tractor-scraper haulage*

| Item | Cost: Material | Cost: Labor | Total cost |
|---|---|---|---|
| Deep-well pump (1) | $30,000 | $25,000 | $55,000 |
| Transformer, etc. for pump | 10,000 | 5,000 | 15,000 |
| Pumphouse (1) | 2,500 | 500 | 3,000 |
| Pipelines | 2,600 | 300 | 2,900 |
| Monitors (3) | 6,200 | 200 | 6,400 |
| Bulldozer (1) | 117,000 | - | 117,000 |
| Tractor-scraper (1) | 172,000 | - | 172,000 |
| Miscellaneous | 14,400 | 1,800 | 16,200 |
| Total direct | - | - | 387,500 |
| Field indirect (50 percent of labor) | - | - | 16,400 |
| Total construction | - | - | 403,900 |
| Engineering (2 percent total construction) | - | - | 8,100 |
| Overhead and administration (2 percent of total construction) | - | - | 8,100 |
| | | | 420,100 |
| Contingency (10 percent) | - | - | 42,000 |
| | | | 462,100 |
| Fee (2 percent) | - | - | 9,200 |
| Total cost (insurance base) | - | - | 471,300 |

TABLE 7. - *Manning table, quenching with tractor-scraper haulage*

| Labor | Wages: Per day | Wages: 240 days per yr |
|---|---|---|
| Pump operator (1) | $33.04 | $7,929 |
| Bulldozer operator (1) | 42.00 | 10,080 |
| Tractor-scraper operator (1) | 42.00 | 10,080 |
| Laborers: | | |
| First shift (2) | 31.60 | 15,168 |
| Second shift (1) | 32.40 | 7,776 |
| Third shift (1) | 32.80 | 7,872 |
| Total wages | - | 58,905 |
| Supervision (15 percent of total wages) | - | 8,835 |

TABLE 8. - *Estimated annual operating costs, quenching with tractor-scraper haulage*

| Item | Annual cost | Cost per cubic yard[1] |
|---|---|---|
| Direct cost: | | |
| Production labor.................. | $58,905 | $0.10 |
| Supervision (15 percent of labor).. | 8,835 | .02 |
| | 67,740 | .12 |
| Operating supplies: | | |
| Maintenance and repairs........... | 6,340 | .01 |
| Fuel and lubrication.............. | 9,850 | .02 |
| | 16,190 | .03 |
| Power............................. | 27,515 | .05 |
| Payroll overhead (35 percent of payroll)........................ | 23,710 | .04 |
| Total direct cost............... | 135,155 | .24 |
| Indirect cost: | | |
| (15 percent of maintenance, labor, and supplies).................. | 12,590 | .02 |
| Fixed cost: | | |
| Taxes and insurance (2 percent of equipment capital cost).......... | 9,425 | .02 |
| Depreciation...................... | 31,370 | .05 |
| | 40,795 | .07 |
| Profit: | | |
| Assumed 12 percent of equipment, capital cost, and estimated working capital................. | 63,910 | .11 |
| Total annual operating cost..... | 252,450 | .44 |

[1]Based on 576,000 cubic yards per year.

TABLE 9. - *Estimated working capital, quenching with tractor-scraper haulage*

| | |
|---|---|
| Direct labor (3 months)......................... | $14,700 |
| Payroll overhead (3 months)..................... | 5,900 |
| Operating supplies (3 months)................... | 4,000 |
| Indirect cost (4 months)........................ | 4,200 |
| Fixed cost (5 percent of insurance base)........ | 23,600 |
| Spare parts..................................... | 3,200 |
| Miscellaneous................................... | 5,700 |
| Total....................................... | 61,300 |

## DISCUSSION AND EVALUATION

The objective of this demonstration was to develop a workable method for extinguishment of burning coal-mine refuse banks. The results of this demonstration show that a burning coal refuse bank can be effectively extinguished


FIGURE 19. - Aerial View at the Completion of the Demonstration.

by cooling with water and hauling the quenched material by earth-moving equipment. Figure 19 is an aerial photograph taken after the demonstration was completed. This photograph may be compared with figure 3. The strip pit was completely backfilled and the surface was graded to correspond with the surrounding surface terrain.

To summarize the method, the use of water may be considered the basic component. The water percolates into and wets the material to reduce the heat below the ignition temperature. In this case, supplying water in large volumes was only a part of the total extinguishment process. The water was effective in reducing the temperature of the hot material only to a limited depth. Even though the water infiltrated the bank in the present test, there could be no assurance that every hot spot within the core of the bank was extinguished because a substantial proportion of the water was undoubtedly converted into steam and evaporated. It is possible that these hot spots are protected and insulated by the hardened and encrusted material. The expansion and contraction due to burning and cooling created cracks and fissures in this protective shell, thus allowing air to enter, supplying sufficient oxygen to permit rekindling the material, and sustaining combustion. The other component in the method was the use of earth-moving equipment to haul the quenched material.

To verify complete extinguishment of the quenched material, a grid pattern of boreholes cased with a 1-inch steel pipe were driven through the entire depth of the quenched material (figs. 19 and 20). The internal temperatures of the material were recorded through the boreholes by using thermocouple lead wires and a portable pyrometer indicator (fig. 21). The borehole temperatures were recorded every month for 6 months following the completion of the project. All readings recorded indicated normal subsurface temperatures relative to the ambient air temperature. These data indicate that the backfilled material was extinguished and has not rekindled.

Table 10 is a recapitulation of the annual production rate and the unit operating cost of the methods tested in this demonstration.

TABLE 10. - *Summary of operating costs*

| Method | Quenching and haulage production, cubic yards per year | Operating cost, per cubic yard |
|---|---|---|
| Hydraulicking with bulldozer haulage.............. | 230,400 | $0.66 |
| Quenching with tractor-scraper haulage............... | 576,000 | .44 |

The method of quenching the material with water and hauling it by tractor-scraper yielded a greater volume at a lower cost than the method of hydraulicking and removal by bulldozer. The tractor-scraper eliminated any need for rehandling material since it picked up material from the bank and deposited it directly in the disposal pit. The slaglike formations were as efficiently broken and hauled as the loose material. Quenching was accomplished at a

FIGURE 20. - Casing Boreholes in Quenched Material for Temperature Recording.

FIGURE 21. - Recording Temperatures of Quenched Material.

greater distance, since high impact pressure was not required as in the hydraulicking method. Also, the working area was relatively flat and easier to traverse providing greater safety to personnel.

Complete and positive extinguishment was obtained only by alternate quenching and removal. The method may be figuratively referred to as the "quench and carry method."

In contemplating the use of this method to extinguish a burning coal refuse bank, some factors to be considered are as follows:

1. The size and shape of the bank.

2. The composition of the material.

3. The availability of an adequate water supply.

4. The proximity of a dumping site.

5. The prevailing wind direction.

6. The number and size of monitors required.

7. The number of bulldozers and tractor-scrapers required.

8. The possible use of a wetting agent.

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# TWO-PHASE EQUILIBRIA OF ANALYTICAL BINARY SOLUTIONS NEAR THE CRITICAL POINT

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

September 1970

# TWO-PHASE EQUILIBRIA OF ANALYTICAL BINARY SOLUTIONS NEAR THE CRITICAL POINT

By B. J. Dalton

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CONTENTS

# TWO-PHASE EQUILIBRIA OF ANALYTICAL BINARY SOLUTIONS NEAR THE CRITICAL POINT

by

B. J. Dalton[1]

ABSTRACT

Several relationships between coexisting phases for analytical binary solutions near the critical point are given. These relationships were developed from a consideration of a (G, u, P) surface at constant temperature and a (G, u, T) surface at constant pressure, where G is the molal Gibbs free energy, u is the concentration of component 1 expressed as a mole fraction, P is the pressure, and T is the temperature. These formulas should facilitate the calculation of some of the quantities useful in making thermodynamic consistency checks on phase equilibria data about the critical point.

## INTRODUCTION

The Bureau of Mines Helium Research Center has an experimental program to obtain compressibility measurements on helium and helium-containing mixtures. The long-range objective is to use these and other critically evaluated data in equations of state studies that allow for the calculation of thermodynamic properties. This includes the calculation of all properties of interest in the two-phase region as well as some of the quantities useful in making thermodynamic consistency checks on phase equilibria data. It may not be possible to achieve this objective because experimental evidence is available that some critical points may be nonanalytical. However, noteworthy progress has been made and fruitful work on this problem has been published recently (1-4, 6-10).[2]

In this report, expressions are developed for coexisting phases of analytical binary solutions near the critical point. These relationships were derived from a consideration of a (G, u, P) surface at constant temperature and a (G, u, T) surface at constant pressure, where G is the molal Gibbs free energy, u is the concentration of component 1 expressed as a mole fraction, P is the pressure, and T is the temperature. These relationships should facilitate the calculation of some of the quantities useful in making thermodynamic consistency checks on phase equilibria data about the critical point.

---

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[2] Underlined numbers in parentheses refer to items in the list of references at the end of this report.

# SOME RELATIONS FOR ANALYTICAL BINARY SOLUTIONS NEAR THE CRITICAL POINT

An analytical binary solution is defined as one for which the molal Gibbs free energy can be written as a double Taylor expansion in the variables of either composition and pressure at constant temperature or composition and temperature at constant pressure about its value at the critical point. The critical point of a binary mixture is defined to be a vapor-liquid state for which all intensive properties are the same for the coexisting phases and is actually described by the simultaneous solution to equations 297 and 298 of reference 5.

Let
$$a = u/u_c - 1 \quad , \tag{1}$$

$$g = \underline{G}/P_c\underline{V}_c \quad , \tag{2}$$

$$p = P/P_c - 1 \quad , \tag{3}$$

$$t = T/T_c - 1 \quad , \tag{4}$$

where u is the concentration of component 1 expressed as a mole fraction, $\underline{G}$ is the molal Gibbs free energy, P is the pressure, T is the temperature, and $u_c$, $P_c$, $T_c$, and $\underline{V}_c$ represent the critical composition, pressure, temperature, and molal volume, respectively.

Expanding g in the variables of a and p at constant temperature about its value at the critical point leads to

$$g = g^{c.p.} + a\, g_a^{c.p.} + p\, g_p^{c.p.} + ap\, g_{a,p}^{c.p.} + \frac{a^4}{24} g_{4a}^{c.p.} + \frac{a^2 p}{2} g_{2a,p}^{c.p.} + \frac{p^2}{2} g_{2p}^{c.p.}$$
$$+ \frac{a^5}{120} g_{5a}^{c.p.} + \frac{a^3 p}{6} g_{3a,p}^{c.p.} + \frac{ap^2}{2} g_{a,2p}^{c.p.} + \ldots \quad \text{T constant} \tag{5}$$

where

$$g_a^{c.p.} = (\partial g/\partial a)_{p,t}^{c.p.} \quad , \tag{6}$$

$$g_p^{c.p.} = (\partial g/\partial p)_{a,t}^{c.p.} \quad , \tag{7}$$

$$g_{a,p}^{c.p.} = (\partial^2 g/\partial a \partial p)_t^{c.p.} \quad , \tag{8}$$

$$g_{4a}^{c.p.} = (\partial^4 g/\partial a^4)_{p,t}^{c.p.} \quad , \tag{9}$$

$$g_{2a,p}^{c.p.} = (\partial^3 g/\partial a^2 \partial p)_t^{c.p.} \quad , \tag{10}$$

$$g_{2p}^{c.p.} = (\partial^2 g/\partial p^2)_{a,t}^{c.p.} \quad , \tag{11}$$

$$g_{5a}^{c.p.} = (\partial^5 g/\partial a^5)_{p,t}^{c.p.} \quad , \tag{12}$$

$$g_{3a,p}^{c.p.} = (\partial^4 g/\partial a^3 \partial p)_{t}^{c.p.} \quad , \tag{13}$$

$$g_{a,2p}^{c.p.} = (\partial^3 g/\partial a \partial p^2)_{t}^{c.p.} \quad . \tag{14}$$

The terms $g_{2a}^{c.p.}$ and $g_{3a}^{c.p.}$ are zero and have not been included in equation 5.

The equilibrium conditions

$$\left\{\mu_1^G - \mu_2^G = \mu_1^L - \mu_2^L ;\ \mu_2^G = \mu_2^L ;\ P^G = P^L\right\} \qquad T \text{ constant,} \tag{15}$$

where $\mu_1$ is the chemical potential of component 1, $\mu_2$ is the chemical potential of component 2, and the superscripts G and L denote vapor and liquid phases, respectively, require that

$$Ap\,(a_1 - a_3) + \frac{B}{3}\,(a_1^3 - a_3^3) + \frac{C}{2}\,p\,(a_1^2 - a_3^2) + \frac{D}{4}\,(a_1^4 - a_3^4) = 0 \tag{16}$$

and

$$\frac{A}{2}\,p\,(a_1^2 - a_3^2) + \frac{B}{4}\,(a_1^4 - a_3^4) + \frac{C}{3}\,p\,(a_1^3 - a_3^3) + \frac{D}{5}\,(a_1^5 - a_3^5) = 0 \quad , \tag{17}$$

where the subscripts 1 and 3 denote vapor and liquid phases, respectively, and the constants A-D are given by

$$A = g_{2a,p}^{c.p.} \quad , \tag{18}$$

$$B = g_{4a}^{c.p.}/2 \quad , \tag{19}$$

$$C = g_{3a,p}^{c.p.} \quad , \tag{20}$$

$$D = g_{5a}^{c.p.}/6 \quad . \tag{21}$$

Equations 16 and 17 are analogous to the mathematical problem for the relationship between coexisting phases of a pure material in the critical region (3).

The relation (5)

$$\left(\frac{dx}{dP}\right)_T = \frac{(1-x)\left[y\Delta\bar{V}_1 + (1-y)\Delta\bar{V}_2\right]}{(y-x)\,(\partial\bar{G}_1^L/\partial x)_{P,T}} \tag{22}$$

leads to

$$\left(\frac{dp}{da_3}\right)_t = \frac{(a_1-a_3)g^L_{2a}}{g^G_p - g^L_p - (a_1-a_3)g^L_{a,p}} \quad . \tag{23}$$

In equation 22, x and y denote mole fractions of component 1 in liquid and vapor phases, respectively, $\Delta V_1 = \overline{V}^G_1 - \overline{V}^L_1$ is the difference in partial molal volumes of component 1 in vapor and liquid phases, $\Delta V_2 = \overline{V}^G_2 - \overline{V}^L_2$ is the difference in partial molal volumes of component 2 in vapor and liquid phases, and $\overline{G}^L_1$ is the chemical potential of component 1 in the liquid phase. In equation 23, g with subscripts indicates partial differentiation of g with respect to the designated subscript.

Equations 5 and 23, combined with the definition of the constants A-D, lead to

$$\left(\frac{dp}{da_3}\right)_t = \frac{6}{(a_1-a_3)}\left\{\frac{Ap + Ba_3^2 + Cpa_3 + Da_3^3}{3A + C(a_1+2a_3)}\right\} \quad . \tag{24}$$

Since, from equation 16,

$$Ap + \frac{B}{3}(a_1^2+a_1a_3+a_3^2) + \frac{C}{2}p(a_1+a_3) + \frac{D}{4}(a_1^3+a_1^2a_3+a_1a_3^2+a_3^3) = 0 \quad , \tag{25}$$

it follows that

$$Ap + Ba_3^2 + Cpa_3 + Da_3^3 = -(a_1-a_3)\left\{\frac{B}{3}(a_1+2a_3) + \frac{C}{2}p + \frac{D}{4}(a_1^2+2a_1a_3+3a_3^2)\right\} \quad , \tag{26}$$

which, when substituted into equation 24, leads to

$$\left(\frac{dp}{da_3}\right)_t = -\frac{4B(a_1+2a_3) + 6Cp + 3D(a_1^2+2a_1a_3+3a_3^2)}{2[3A + C(a_1+2a_3)]} \quad . \tag{27}$$

Equation 16 gives

$$-p = \frac{4B(a_3^2+a_1a_3+a_1^2) + 3D(a_3^3+a_3^2a_1+a_3a_1^2+a_1^3)}{12A + 6C(a_1+a_3)} \quad \text{T constant.} \tag{28}$$

Substituting for p into the right-hand side of equation 17, we then have as the relation for $a_1$ as a function of $a_3$, to second order,

$$a_1 = -a_3[1+Ma_3] \qquad \text{T constant,} \tag{29}$$

where

$$M = (3D/5B) - (C/3A) \quad . \tag{30}$$

Substituting for $a_1$ from equation 29 into equation 28, then to second order

$$-p = (B/3A)[1+Ma_3]a_3^2 \qquad \text{T constant} \tag{31}$$

or

$$a_3 = -(-3Ap/B)^{1/2}[1-\frac{M}{2}a_3] \qquad \text{T constant.} \tag{32}$$

Substituting the first approximation for $a_3$ into the right-hand side of equation 32,

$$a_3 = (3A/2B)Mp - (-3Ap/B)^{1/2} \qquad \text{T constant.} \tag{33}$$

Equations 29 and 33 lead to

$$a_1 = (3A/2B)Mp + (-3Ap/B)^{1/2} \qquad \text{T constant.} \tag{34}$$

Substituting equations 29 and 31 into equation 27, then to second order,

$$(dp/da_3)_t = -(B/3A)[\cdot 2+3Ma_3]a_3 \quad . \tag{35}$$

The relation (5)

$$\left(\frac{dy}{dP}\right)_T = \frac{(1-y)[x\Delta\overline{V}_1 + (1-x)\Delta\overline{V}_2]}{(y-x)(\partial\overline{G}_1^G/\partial y)_{P,T}} \tag{36}$$

leads to

$$\left(\frac{dp}{da_1}\right)_t = \frac{(a_1-a_3)g_{2a}^G}{g_p^G-g_p^L-(a_1-a_3)g_{a,p}^G} \quad . \tag{37}$$

Proceeding in a manner similar to that used in developing equation 27, we find

$$\left(\frac{dp}{da_1}\right)_t = -\frac{4B(a_3+2a_1)+6Cp+3D(a_3^2+2a_1a_3+3a_1^2)}{2[3A+C(a_3+2a_1)]} \tag{38}$$

or substituting equations 29 and 31 into equation 38,

$$-(dp/da_1)_t = -(B/3A)[2-Ma_3]a_3 \tag{39}$$

to second order.

The sign of the right-hand side of equations 35 and 39 is determined by that of $A = g_{2a,p}^{c.p.}$, since $B = g_{4a}^{c.p.}/2$ is necessarily positive (10). If below the critical point $a_1 > 0 > a_3$, then $\pm(dp/da_3)_t > 0 > \pm(dp/da_1)_t$, where the positive sign is applicable if $A > 0$ and the negative sign is applicable if $A < 0$; at the critical point these two pressure derivatives vanish. This is also equivalent to

$$\pm(dP/dx)_T^{c.p.} = \mp(dP/dy)_T^{c.p.} = 0 \quad , \tag{40}$$

which means that a critical binary mixture is at the maximum or minimum pressure of a P versus u curve at constant temperature.

An analogous development for the temperature-composition derivatives can be obtained from a consideration of a (g, a, t) surface at constant pressure, together with the two relations (5)

$$\left(\frac{dy}{dT}\right)_P = -\frac{(1-y)[x\Delta\bar{S}_1 + (1-x)\Delta\bar{S}_2]}{(y-x)(\partial\bar{G}_1^G/\partial y)_{P,T}} \tag{41}$$

and

$$\left(\frac{dx}{dT}\right)_P = -\frac{(1-x)[y\Delta\bar{S}_1 + (1-y)\Delta\bar{S}_2]}{(y-x)(\partial\bar{G}_1^L/\partial x)_{P,T}}\ , \tag{42}$$

which can be expressed in the variables g, a, and t as (or, strictly speaking, their reciprocals)

$$\left(\frac{dt}{da_1}\right)_p = -\frac{(a_1-a_3)g_{2a}^G}{g_t^G - g_t^L - (a_1-a_3)g_{a,t}^G} \tag{43}$$

and

$$\left(\frac{dt}{da_3}\right)_p = -\frac{(a_1-a_3)g_{2a}^L}{g_t^G - g_t^L - (a_1-a_3)g_{a,t}^L}\ . \tag{44}$$

The results are, to second order,

$$a_1 = -a_3[1+Na_3] \qquad \text{P constant,} \tag{45}$$

where

$$N = (3D/5B) - (F/3E)\ , \tag{46}$$

$$E = g_{2a,t}^{c.p.} = (\partial^3 g/\partial a^2\partial t)_p^{c.p.}\ , \tag{47}$$

$$F = g_{3a,t}^{c.p.} = (\partial^4 g/\partial a^3\partial t)_p^{c.p.}\ , \tag{48}$$

$$a_1 = (3E/2B)Nt + (-3Et/B)^{1/2} \qquad \text{P constant,} \tag{49}$$

$$a_3 = (3E/2B)Nt - (-3Et/B)^{1/2} \qquad \text{P constant,} \tag{50}$$

$$-t = (B/3E)[1+Na_3]a_3^2 \qquad \text{P constant,} \tag{51}$$

$$-(dt/da_1)_p = -(B/3E)[2-Na_3]a_3, \tag{52}$$

$$(dt/da_3)_p = -(B/3E)[2+3Na_3]a_3 \tag{53}$$

In equations 41 and 42, $\Delta\bar{S}_1 = \bar{S}_1^G - \bar{S}_1^L$ is the difference in partial molal entropies of component 1 in vapor and liquid phases, and $\Delta\bar{S}_2 = \bar{S}_2^G - \bar{S}_2^L$ is the difference in partial molal entropies of component 2 in vapor and liquid phases.

The sign of the right-hand sides of equations 52 and 53 is determined by that of $E = g_{2a,t}^{c.p.}$. If below the critical point $a_1 > 0 > a_3$, then $\pm(dt/da_3)_p > 0 > \pm(dt/da_1)_p$, where the positive sign is applicable if $E > 0$ and the negative sign is applicable if $E < 0$; at the critical point these two temperature derivatives vanish. This is equivalent to

$$\pm(dT/dx)_P^{c.p.} = \mp(dT/dy)_P^{c.p.} = 0 \quad , \tag{54}$$

which can be ascertained from the reciprocal of equation 5.29 of Rowlinson (10). Hence, a critical binary mixture is at the maximum or minimum temperature of a T versus u curve at constant pressure.

Since (5)

$$\left(\frac{dP}{dT}\right)_y = -\frac{(dy/dT)_P}{(dy/dP)_T} \quad , \tag{55}$$

which can be expressed in the variables a, p, and t as

$$\left(\frac{dp}{dt}\right)_{a_1} = -\frac{(da_1/dt)_p}{(da_1/dp)_t} = -\frac{(dp/da_1)_t}{(dt/da_1)_p} \quad , \tag{56}$$

then from equations 39, 52, and 56,

$$(dp/dt)_{a_1} = -(E/A)\left[1 + \frac{(N-M)}{2}a_3 + \frac{N(N-M)}{4}a_3^2\right] \quad . \tag{57}$$

Equations 35, 53, and the relation (5)

$$\left(\frac{dP}{dT}\right)_x = -\frac{(dx/dT)_P}{(dx/dP)_T} \quad , \tag{58}$$

which can be expressed in the variables a, p, and t as

$$\left(\frac{dp}{dt}\right)_{a_3} = -\frac{(da_3/dt)_p}{(da_3/dp)_t} = -\frac{(dp/da_3)_t}{(dt/da_3)_p} \quad , \tag{59}$$

lead to

$$(dp/dt)_{a_3} = -(E/A)\left[1 - \frac{3(N-M)}{2}a_3 + \frac{9N(N-M)}{4}a_3^2\right] \quad . \tag{60}$$

Thus, a critical point occurs at some point below the maximum pressure or above the minimum pressure of a P versus T curve at constant composition.

Define

$$v = \underline{V}/\underline{V}_c - 1, \tag{61}$$

where $\underline{V}$ is the molal volume. Since $(\partial \underline{G}/\partial P)_{T,u} = \underline{V}$, it follows that

$$v = (\partial g/\partial p)_{a,t} - (\partial g/\partial p)^{c.p.}_{a,t} \quad ,$$

$$= a\, g^{c.p.}_{a,p} + \frac{a^2}{2}\, g^{c.p.}_{2a,p} + p\, g^{c.p.}_{2p} + \frac{a^3}{6}\, g^{c.p.}_{3a,p} + ap\, g^{c.p.}_{a,2p} \quad ,$$

$$= a\, g^{c.p.}_{a,p} + \frac{a^2}{2} A + p\, g^{c.p.}_{2p} + \frac{a^3}{6} C + ap\, g^{c.p.}_{a,2p} \qquad T \text{ constant.} \tag{62}$$

For the saturated liquid phase, equations 31, 35, and 62 lead to

$$(dv^L/da_3)_t = g^{c.p.}_{a,p} + a_3[A - (2B/3A) g^{c.p.}_{2p}] \tag{63}$$

to second order. At the critical point, equation 63 is equivalent to

$$(d\underline{V}^L/dx)^{c.p.}_T = (\partial \underline{V}^L/\partial x)^{c.p.}_{P,T} = (\overline{V}^L_1 - \overline{V}^L_2)^{c.p.} \ . \tag{64}$$

For the saturated vapor phase, equations 29, 31, 39, and 62 lead to

$$(dv^G/da_1)_t = g^{c.p.}_{a,p} - a_3[A - (2B/3A) g^{c.p.}_{2p}] \tag{65}$$

to second order. At the critical point, equation 65 is equivalent to

$$(d\underline{V}^G/dy)^{c.p.}_T = (\partial \underline{V}^G/\partial y)^{c.p.}_{P,T} = (\overline{V}^G_1 - \overline{V}^G_2)^{c.p.} \quad , \tag{66}$$

which has been given previously by equations 30 and 31 of the paper by Redlich and Missen (9). Since, in general, the partial molal volumes are not the same,[3] equations 64 and 66 are finite and nonzero. If below the critical point $a_1$ and $v^L > 0 > a_3$ and $v^G$, then at the critical point $(dv^L/da_3)_t = (dv^G/da_1)_t < 0$. On the other hand, if below the critical point $a_1$ and $v^G > 0 > a_3$ and $v^L$, then $(dv^G/da_1)^{c.p.}_t = (dv^L/da_3)^{c.p.}_t > 0$.

From equation 438 of reference 5, it can be shown that

$$\left(\frac{dp}{dv^L}\right)_t = \frac{(dp/da_3)_t}{(dv^L/da_3)_t} \ . \tag{67}$$

Equations 35, 63, and 67 lead to

$$\left(\frac{dp}{dv^L}\right)_t = -\frac{(2B/3A)}{(g^{c.p.}_{a,p})^2}\, a_3\left[g^{c.p.}_{a,p} + \left\{\frac{3}{2} M g^{c.p.}_{a,p} - A + \frac{2B}{3A} g^{c.p.}_{2p}\right\} a_3\right] \quad , \tag{68}$$

while equations 39, 65, and the relation

$$\left(\frac{dp}{dv^G}\right)_t = \frac{(dp/da_1)_t}{(dv^G/da_1)_t} \tag{69}$$

[3]An azeotrope is an exception to this and is discussed by Rowlinson (10, pp. 194-200).

give

$$-\left(\frac{dp}{dv^G}\right)_t = -\frac{(2B/3A)}{(g^{c.p.}_{a,p})^2}\, a_3\left[g^{c.p.}_{a,p} - \left\{\frac{M}{2}\, g^{c.p.}_{a,p} - A + \frac{2B}{3A}\, g^{c.p.}_{2p}\right\}a_3\right] \quad . \tag{70}$$

Thus, below the critical point $(dp/dv^L)_t$ and $(dp/dv^G)_t$ are of opposite sign, while at the critical point these two derivatives vanish. This is equivalent to

$$\pm(dP/d\underline{V}^L)^{c.p.}_T = \mp(dP/d\underline{V}^G)^{c.p.}_T = 0 \quad . \tag{71}$$

The result $(dP/d\underline{V}^G)^{c.p.}_T = 0$ checks equation 32 of reference 9.

From equations 35 and 39, it can be shown that, to second order,

$$[(da_3/dp)_t + (da_1/dp)_t] = (3A/B)M\left[1 - Ma_3 + \frac{7}{4}M^2\ a_3^2\right] \tag{72}$$

and

$$[(da_3/dp)_t - (da_1/dp)_t] = -(3A/B)\left[1 - \frac{M}{2}\ a_3 + \frac{5}{4}M^2\ a_3^2\right]a_3^{-1} . \tag{73}$$

If below the critical point $a_1 > 0 > a_3$ and A is positive, then the slope of the composition versus pressure curve at constant temperature of the saturated liquid exceeds that of the saturated gas below the critical point and their difference becomes infinite at the critical point. In addition, although each of these slopes become infinite at the critical point, their sum is finite, as equation 72 shows. At the critical point, equation 73 is equivalent to

$$(dx/dP)^{c.p.}_T - (dy/dP)^{c.p.}_T = \pm\infty \quad . \tag{74}$$

Similarly,

$$[(da_3/dt)_p + (da_1/dt)_p] = (3E/B)N\left[1 - Na_3 + \frac{7}{4}N^2\ a_3^2\right] \tag{75}$$

and

$$[(da_3/dt)_p - (da_1/dt)_p] = -(3E/B)\left[1 - \frac{N}{2}\ a_3 + \frac{5}{4}N^2\ a_3^2\right]a_3^{-1} \tag{76}$$

which follow from equations 52 and 53. At the critical point, equation 76 is equivalent to

$$(dx/dT)^{c.p.}_P - (dy/dT)^{c.p.}_P = \pm\infty \quad . \tag{77}$$

Equations 71 and 73 lead to

$$[(dv^L/dp)_t + (dv^G/dp)_t] = (3A/B)\left[Mg^{c.p.}_{a,p} - A + \frac{2B}{3A}\ g^{c.p.}_{2p}\right](1 - Ma_3) , \tag{78}$$

which, for normal binary mixtures, is finite at the critical point. The difference between these same two derivatives, however, becomes infinite at the critical point, which is equivalent to

$$(d\underline{V}^G/dP)_T^{c.p.} - (d\underline{V}^L/dP)_T^{c.p.} = \pm\infty \quad , \tag{79}$$

where the positive sign is applicable if $a_1$ and $v^L > 0 > a_3$ and $v^G$, and the negative sign is applicable if $a_1$ and $v^G > 0 > a_3$ and $v^L$.

Equations 40 and 54 imply

$$\pm(d^2P/dx^2)_T^{c.p.} = \pm(d^2P/dy^2)_T^{c.p.} < 0 \tag{80}$$

and

$$\pm(d^2T/dx^2)_P^{c.p.} = \pm(d^2T/dy^2)_P^{c.p.} < 0 \quad . \tag{81}$$

Equations 71, 80, and the relation

$$[d^2P/d(\underline{V}^G)^2]_T^{c.p.} = \left[(d^2P/dy^2)_T\,(dy/d\underline{V}^G)_T^2\right]^{c.p.} \quad , \tag{82}$$

which follows from equation 41 of reference 9, lead to

$$\pm[d^2P/d(\underline{V}^L)^2]_T^{c.p.} = \pm\left[d^2P/d(\underline{V}^G)^2\right]_T^{c.p.} < 0 \quad . \tag{83}$$

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